Vol 1

# METHODS FOR PRICING THE TECHNICAL COMPONENT OF DIAGNOSTIC TESTS

by

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Leonard Davis Institute of Health Economics
University of Pennsylvania

June, 1989

Volume 1 of 2

This research was supported by cooperative agreement No. 99-C-99169/5--01 from Health Care Financing Administration. The views and opinions are those of the grantees and no endorsement by HCFA or DHHS is intended or should be inferred.

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July 21, 1989

Sherry Terrell, Ph.D.
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Dear Sherry,

Enclosed is the final report of the study "Methods for Pricing the Technical Component of Diagnostic Tests," completed under HCFA Cooperative Agreement No. 99-C-99169/5-01. The appendices will be sent on Monday, July 24 in a separate package.

The final report addresses your comments and those of your colleagues to the draft report and at the presentation given by Mark Pauly and Jim Highland.

It has been a pleasure working with you on this project and your support has been very helpful. Please call us with any questions you might have concerning this study.

Sincerely,

Orit Even-Shoshan

Orit Even-Shoshan
Project Manager

OE-S:tf

Enclosures

cc: Roger Feldman, Ph.D.

JUL 24 1989

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# EXECUTIVE SUMMARY

## BACKGROUND

Use of medical tests in physicians' offices is growing and is believed to be an important factor in the growth of Part B expenditures. Concerned that this increase was excessive and was being transferred to beneficiaries in the form of cost sharing, Congress has enacted several changes in the methods used to pay for clinical laboratory tests. Both DEFRA and COBRA addressed the question of how physicians should be paid for clinical laboratory tests they provide or order. Non-laboratory diagnostic tests, in contrast, continue to be paid on the basis of reasonable charges. OBRA 1987, effective in April, 1988, introduced changes in billing for such tests purchased from outside suppliers. A final national uniform policy for determining payment level for diagnostic tests performed in the physician's office is unresolved.

This study investigates methods to evaluate charge levels for diagnostic tests. Charges can be "global," intended to cover the physician's professional services and the technical component, or they can be for either component. We examine all three elements.

There are two senses in which current Medicare reimbursement levels might be judged to be inappropriate. On the one hand, if there is large and inexplicable variation across specialties, carriers, or geographic areas, both efficiency and equity may suffer. On the other hand, the level of payment could be either too high or too low, relative to the level that would induce an appropriate supply of services.

We therefore selected a set of sixteen diagnostic tests, chosen because of their high volume, high total cost, or high level of policy interest. We

use Medicare data to measure the variability of payment levels for the global fee and the technical component of these tests.

We investigate two different ways of assessing the appropriateness of payment levels. First, we compare current payment levels in large HMOs and PPOs with Medicare levels. Second, we examine the possibility of identifying levels which will yield a normal or market level of return on the capital the doctor has invested in the test equipment.

Finally, we consider alternative methods of payment. We explore the desirability and feasibility of a volume-related payment system, one that would pay different prices to different doctors depending on the volume of total tests they run. We find that such an arrangement would have some attractive incentive and equity aspects.

SPECIFIC TASKS

The specific tasks performed in this project are as follows:

- Analysis of BMAD data to assess diagnostic tests billing methods and variation in payments for the highest volume tests. We identified the relevant diagnostic tests, and their global and professional fees. The implied technical components of the highest volume diagnostic tests were estimated by comparing mean charges for services billed globally with those billed for professional services only; this "technical differential" was examined at the national level, within regions, within carrier areas, and across specialties.
- Analysis of methods and criteria for determining appropriateness of payment levels for technical components.
- Evaluation of the desirability and feasibility of using pricing based

on returns to investment to determine the lowest price for the technical component conditional to adequate quality and access.

- Determination of reasonable charges for the technical component of high volume diagnostic tests based on a net present value approach.
- Real time and Holter monitors--an analysis of the current pricing and determination of reasonable charges.
- Comparison of mean medical global and technical fees with payment levels set by private sector IPA-type organizations.

## THE MEANING OF "APPROPRIATE CHARGES" IN THIS CONTEXT

The most fundamental economic definition of an appropriate charge/reimbursement for diagnostic tests is the same as for other medical services: a level of payment just sufficient to induce doctors to make appropriate volumes of tests of appropriate quality available to beneficiaries. Diagnostic tests differ from other Medicare services in that capital equipment costs are much higher (relative to other costs), compared to physician office services with a heavy professional component. The need for the patient to be present for the service is greater for diagnostic tests than for clinical laboratory tests. These two differences mean that appropriate pricing might well be based on consideration of the return to the capital investment, but that specification of appropriate volume/access for the patient in each doctor's office will be relevant.

## ANALYSIS OF MEAN CHARGE VARIATION FOR DIAGNOSTIC TESTS BASED ON 1986 BMAD DATA

Tests to be analyzed in this project were determined by surveying a small sample of expert clinicians and asking them to select the most important tests based on physical volume, dollar volume, perceived profit margin, access, and

the number of different specialties performing the test. Based on these criteria eleven test categories were selected for study. One of the categories, orthopedic X-rays, has five sub-categories (shoulder, hip, pelvis, knee, and foot), and chest X-rays can either be one view or two views. The final list therefore consisted of sixteen different tests, as follows:

1. Chest X-ray, one view
2. Chest X-ray, two views
3. Routine EKG
4. Holter Monitor
5. Real-time EKG Monitor
6. Peripheral Vascular Tests
7. Spirometry
8. CAT Scan of Head
9. X-ray of Shoulder
10. X-ray of Pelvis
11. X-ray of Hip
12. X-ray of Knee
13. X-ray of Foot
14. Upper GI X-ray
15. Abdominal Ultrasound
16. Ophthalmic Biometry

These tests represent a sizable Part B expenditure. In 1986, allowed charges for these procedures amounted to $1.4 billion, which was six percent of total Part B allowed charges. Routine EKGs alone amounted to $270 million, or more than one percent total Part B allowed charges. Moreover, the methods of evaluation we have developed in this study could be used for other diagnostic tests as well (both clinical laboratory tests and non-laboratory diagnostic tests).

In principle, Medicare currently can be billed or pay in three ways for any of these tests. It can pay the doctor on a "global" (no relevant modifier) basis, with a single payment intended to cover both the professional component of the test and the technical component of a test performed in the doctor's office. It can pay for the professional (usually physician) component only. Or it can pay for the technical component only.

Physicians are supposed to receive payment only for the professional component for tests performed at the hospital, since the hospital is paid separately for the technical component. However, carriers differ in the

extent to which they code hospital tests with a modifier to indicate "professional only" versus no relevant modifier. Tests performed in the office can in principle have a modifier attached to indicate technical or professional component. In practice, however, use of a modifier to indicate technical component only for office tests is quite rare. Only EKGs, which have separate HCPCS codes for technical and professional components, display meaningful frequencies for the technical component of tests with office as the site. For other office tests, charges are either coded professional only, or are global (with no relevant modifier code).

However, even though there is usually no explicit payment for the technical component of office tests, it is possible to calculate an "estimated technical differential" for any population of physicians and patients by subtracting the mean hospital charge for a test, which is intended to represent payment for the professional component only, from the mean office global charge. The estimate represents the difference in mean charges for services billed in different settings; since many physicians bill in only one setting, it does not represent physician--or carrier-specific differentials. However, it does provide a plausible (if not perfect) estimate of the additional revenue a physician would expect to receive from Medicare if the test site was changed from hospital to office; it provides an estimate of the additional money one would get from doing tests using capital equipment in one's office. We therefore examined the levels and variation in mean global approved charges for office services, mean charges for hospital services, and mean estimated technical differentials. We examined the variation in approved charges by specialty, by HCFA region given specialty, by carrier given specialty, and by pricing locality within carrier region, given specialty.

Variation by Specialty. We examined variation in nationwide mean charges for the four specialties with the highest volume for each test. For most of the tests, there is only modest variation across specialties in mean charges for global office fees, hospital professional fees, or the estimated technical differential. For bilateral chest X-rays, CT scans, Holter monitoring, and upper GI X-rays there is little variation across specialties. One specialty is out of line, but the others are quite similar, for most of the other tests. For the orthopedic tests, orthopedic surgeons consistently have a low estimated technical fee differential because they consistently have higher charges for the hospital professional component. For other tests, other specialties are sometimes the "low outlier": radiology for single-view chest X-rays and family practice for routine EKGs. Other tests have "high outliers": general practice for spirometry and cardiovascular specialties for peripheral vascular testing. Finally, two tests do show wide variation in mean charges and mean differentials across specialties: ophthalmic biometry and real-time EKG monitoring. The former test has very low volume for all specialties other than ophthalmology, and the latter is a relatively new test with rapidly changing technology.

Regional Variation. We examined the variation across HCFA regions for each of the tests for the two highest frequency specialties. The variation in global office fee levels is quite low. The variation in mean hospital charges for professional component is, however, somewhat higher, and there is substantial variation across regions in the implicit technical differential for some of the tests. The variation in the technical differential is low for X-rays, especially for radiologists, but is substantial for most of the other tests. The implied technical differential for vascular tests, for example, varies

from $6 in the Boston and Denver regions to $75 in the Chicago region. There is, however, little consistency in this geographic variation; regions which display an unusually high differential for one test do not consistently rank high for other tests.

Carrier Variation. This pattern is repeated and accentuated in the variation across all carriers, relative to the national mean. Analysis is somewhat more difficult here because some carriers have low volumes for specific tests in specific sites for specific specialties. However, the coefficient of variation for global fees is quite low, very rarely above 15 percent and frequently below 10 percent for the orthopedic X-rays. (This "coefficient of variation" here measures the variation between carrier mean charges and the national mean charge). In contrast, the variation for the implied technical differential is large, with coefficients of variation as high as 50 percent.

At HCFA's request we determined whether carriers often pay different average charges for the two alternative codes for hospital tests. Tests performed in the hospital can either be billed as "professional fee" or with no modifier. In either case, the bill should be for the physician's interpretation only, since the hospital bills separately for the technical component. We found that most carriers pay physicians for tests where the hospital provides the technical component primarily with one or the other code. When there are appreciable numbers of tests coded in both ways for a given specialty in a given carrier, the differences are usually small and are never more than moderate.

Variation Across Pricing Localities. Finally, we examined the variation in mean charges across pricing localities relative to the carrier mean charge.

This measure tells us whether a doctor could alter the mean charge or mean differential received by moving within a carrier region. Here again, we calculate deviations of mean prices in each pricing locality from the mean of the carrier in which the pricing locality is included, and again, the coefficient of variation in global fees is small. But also, as before, the coefficient of variation across pricing localities for the implied technical differential is large, although in this analysis the problem of small numbers of observations is common.

Conclusion. The existence of substantial variation in the price currently paid for the technical differential, or other components of total price, raises questions about the appropriateness of current pricing policy. We found that there was usually little variation across specialty for the technical component, the global charge, or the professional component. There is little geographic variation in the global charges, but there is moderate variation in the professional services component. However, there is always substantial variation across regions, across carriers, and across pricing localities for the implied technical differential. This variation of multiple orders of magnitude is obviously too large to be explained by differences in input prices, especially since the price of the diagnostic equipment is approximately uniform nationwide. Different physicians in different places will see very different levels of profitability in investing in equipment to perform diagnostic tests in the office.

## IPA SURVEY AND COMPARISON WITH MEDICARE ALLOWED CHARGES

One way to judge the level of current Medicare allowed charges is by comparing them with what other private sector aggressive buyers are paying.

We obtained data on prices paid for the technical and global fees for the sixteen diagnostic tests from a nationwide set of sixteen large IPAs. All respondents had more than 50,000 members. Not all IPAs furnished information on all comparisons, with separate payment levels for the technical component only being rarer than payments set for a global fee.

We compared the average 1988 IPA payments with the average payment from the BMAD data for all specialties, updated from 1986 to 1988 by using the Medicare Economic Index. The fees for radiology and ophthalmic biometry were up dated using the limits imposed by new regulations on the rate of increase in prevailing charges. The results indicated that IPAs usually pay more than the updated Medicare charges for either the global fee or the technical component. IPA charges exceed mean Medicare charges by the largest percentage amount for peripheral vascular tests, CT scans, and the technical component of orthopedic X-rays. Medicare paid more than the IPAs for EKGs. In all cases the differences were at most moderate; compared to this sample of private sector behavior, Medicare is neither grossly overpaying nor underpaying.

**PRICING BASED ON RETURNS ON INVESTMENT**

The notion of basing the maximum price paid for a commodity on the return on capital invested in the production of that commodity has a long history in the regulated public utility industries. The fundamental notion is that the price should be just sufficient to yield a return on equity capital which equals the market or normal return earned on similar investments elsewhere in the economy. Adaptation of this approach to the medical care market, with multiple sellers and variable quality, is not simple--and its performance in the public utility world has also been strongly criticized. Nevertheless, it

does appear possible to base prices on returns on capital if one additional design issue is settled: Medicare must specify the minimum volume level in a doctor's office that it is willing to support. Because of the high fixed cost of test equipment, such services are inevitably subject to economies of scale. This means that any of a wide range of prices will be a "normal return" or breakeven price (given the opportunity cost of equity capital), depending on the level of volume selected.

In contrast to the standard public utility case where the regulated firm's volume is determined by the total demand in the community and the requirement that the utility serve those demanders, there is no unique individual-physician demand for diagnostic tests. There is only one electric company, but there are many doctors and clinics. Hence, Medicare must specify what level of minimum volume ("access," in this limited sense) it wishes to buy. In addition, if doctors differ in volume levels (above the minimum) or in managerial skill, a given price which yields a normal-return at the margin will always yield an above-average return to doctors with greater than marginal levels of volume or skill.

We examined the kinds of information needed to calculate estimated technical component prices based on the return on capital model for the sixteen tests. The objective was to determine normal-return prices at plausible estimates of currently prevailing volume levels. Comparing such normal-return prices with the updated mean Medicare technical differentials from the BMAD data would then suggest whether current price levels are excessive for those volume levels. (Of course, if the desired minimum volume level were lower than the plausible estimates we used, an "excessive" price would still be appropriate).

We also calculated the normal-return volume implied by updated average Medicare mean technical differentials. This would be the lowest (not the average) volume that would be financially supported by that price.

The overall model is one which calculates the price level which would just cover the risk adjusted opportunity cost of equity capital. We used the Net Present Value (NPV) approach, which adjusts for tax advantages and the mix of debt and equity in the capital financing mix.

Information to estimate breakeven prices was obtained in an informal way from manufacturers' representatives. Because capital equipment for these tests comes in a wide range of prices and expected operating costs, and because the machine purchased by a specialist who expects to run many complex tests is different from that typically bought by a non-specialist, we developed four scenarios to bracket the range of possible prices. We developed "low cost" and "high cost" scenarios for a typical specialist and for a typical generalist. Because these scenarios are based on estimates thought to be plausible but not confirmed by large scale data collection, they should not be viewed as precise measures of appropriate prices, but rather should be viewed as illustrating the method and as indicators of tests whose current medicare technical component charges appear most likely to differ appreciably from normal-return prices.

We asked our respondents for the typical price and volume of a machine that would be bought by either a specialist or a non-specialist. (Some tests were only performed by specialists). Operating costs, costs for space and supplies, marginal tax rates, and estimates of total volume (on the machine) and percentage utilization (for the test in question) were developed.

Tables 1 and 2, which append this chapter show the assumptions made for each test, the normal-return prices for each of the four scenarios, updated Medicare mean technical differentials for comparison purposes, and the normal-return volume estimates based on mean technical differentials for all specialties. All calculations are based on an assumed required real rate of return of 10% (5% inflation-adjusted (real) risk-free rate plus 5% risk premium).

A few of the tests have normal-return prices which are quite close to the updated mean Medicare estimated technical differentials. This is especially true for X-rays, EKGs, and CT scans.

In contrast, Medicare payment levels appear to be excessive for peripheral vascular testing, abdominal ultrasound, and ophthalmic biometry, and possibly for Holter and real-time monitoring. The mean price actually paid is several orders of magnitude greater than estimated normal-return prices, given the assumed volume. For example, the average Medicare updated technical differential for peripheral vascular is $68.88 as compared to a normal return price of $10.62 for a low end non-specialist and $25.97 for a high end specialist. Similarly, Medicare pays $77.03 on the average for the technical differential of abdominal echography while the normal-return range of prices is between $15.42 for a low end non-specialist to $48.28 for a high end specialist. Particularly for the newer tests or those with changing technology, overpayment is strongly suggested.

## HOLTER AND REAL-TIME MONITORING: ANALYSIS OF PREVAILING CHARGES

The measured mean payment levels in the BMAD data for Holter and real-time monitoring may not be wholly accurate, given the small number of such

tests performed and possible ambiguity in coding. At HCFA's requests, we therefore obtained data from carriers on their prevailing (not mean approved) charges for each of these tests, both for the global fee and for the separate components and we compared these levels with the estimated normal-return prices.

Analog Holter monitoring appears to have normal-return prices below the mean Medicare prevailing charges. As this procedure is increasingly converted to using digital technology, the gap between the prevailing charge and the normal-return price will become more significant, because it is larger for digital technology than for analog technology. Real-time analysis also had normal-return prices well below the mean prevailing charge under most reasonable sets of assumptions. Precise definition of the output of the technical component and the ability of specific equipment to produce the defined output are important issues for all ambulatory cardiac monitoring technologies.

## TOWARD A SUGGESTED REMEDY

Even getting the price to the normal-return level for the minimum desired volume will not be ideal from HCFA's point of view. The price will still yield positive returns in excess of the normal-return for practices with larger volumes, and there will still be an incentive to increase volume, especially for large practices, because the price exceeds marginal cost. A better pricing strategy would be one in which the unit price varied with a practice's total volume for each test. Such an arrangement would "track" the average normal-return price at different volumes, as estimated by the NPV analysis.

If it was desired to discourage especially low volumes, the price for low volumes could be set well below the normal-return level. In general, it would be possible to "tilt" the price schedule (relative cost) to encourage or discourage whatever volumes Medicare wished. Alternatively, setting price equal to average cost at every volume level would leave price neutral with regard to physician decisions to acquire the capability of office testing, and the incentive to increase test volumes once the capability had been acquired.

The major impediment to implementing this scheme is the ability to measure and monitor total volume, not just Medicare volume. If total volume were always proportional to Medicare volume, this would not be a problem. But since the ratio probably varies, basing price on Medicare volume alone--which HCFA could easily monitor--may still lead to distorted incentives and payments. However, it may be possible to determine a reasonably consistent relationship between Medicare volume and total volume, and use that relationship to at least approximate the ideal price schedule.

## CONCLUSION

Our analysis suggests that current prices for x-rays of all types (chest, orthopedic, GI), EKGs, and CT scans are probably close to appropriate. In contrast, under all of the scenarios we examined, the prices for ophthalmic biometry, echography (ultrasound) and peripheral vascular testing appear to be well out of line. For these tests, either the current prices are very wrong or the assumptions used in our scenarios, despite their plausibility, are well off the mark. Whichever is true, further analysis would be warranted. Finally, there is a strong suggestion, but not unequivocal evidence, of

overpricing for spirometry (for specialists), and for Holter and real-time EKG monitoring.

There are three kinds of additional analysis that would shed light on these questions. First, it would be useful to document the distribution of total (not just Medicare) test volumes for physician owned equipment. The most uncertain part of our NPV analysis was the estimation of plausible volumes. Manufacturers' representatives did not feel that they had good information on the volumes doctors envisioned. Instead, sales materials invariably invite doctors to fill in their own estimated volume. The claims for enormous profits or rapid payback of investment for diagnostic testing which are often made all depend critically on volume levels achieved, and it is up to doctors to decide what volume level is plausible for their practices. An empirical study of typical volume levels for physicians who own their own test equipment would therefore be highly valuable. Other BMAD data sets (not the one made available to this project) might permit calculation of the number of Medicare tests associated with a particular physician or physician billing number. Particularly after April, 1988, when regulations were changed so that the doctor could not bill for a global fee for a test that was actually referred out, one might get an accurate idea of the distribution of Medicare volume. But measurement of total volume, Medicare and non-Medicare, is needed to calculate total return, so that a physician survey (perhaps a modification of the Survey of Physicians' Practice Costs and Income) is suggested.

The second useful piece of information would bear on the value of in-office testing. How much greater convenience, and greater access, is provided to beneficiaries by having in-office testing? Almost any physician in internal medicine would be advised, on quality and safety dimensions alone, to

have the capability of administering routine EKGs, but are there other analogous precepts for other specialties and other tests? Some standard-setting, and some analysis of effectiveness and cost, may be appropriate here.

The third piece of information concerns the relationship between test profits and other charges the doctor makes. One might well expect that doctors who profit more from tests they furnish would, on that account, be willing to set prices for other components of the patient encounter lower. Particularly when some part of test users do pay out-of-pocket for doctor visits, it may be a reasonable pricing strategy to charge less for visits in order to encourage visits when the visit is the gateway to a profitable test.

For non-Medicare customers with insurance coverage for lab tests but not for routine office visits, it may be a sensible strategy to overprice the former and underprice the latter; the customary charge limitation may transfer this pattern to Medicare charges as well. Before becoming too aggressive about overpriced tests, one may wisely investigate whether there are offsets elsewhere in the "visit bundle." Nevertheless, the strong profit incentive to test should probably be attenuated even if such offsets are found.

There may be net advantages to Medicare in reducing prices for some tests. However, we argue that a preferable strategy -- and one that does not require setting volume levels per practice -- is a method of payment in which the unit price depends on volume. Given the heavy fixed cost component for these tests, this may be a reasonable strategy.

The final conclusion appears to be one calling for change, but cautions change. Simply forcing down Medicare payment level is too much of a blunt instrument. But nontrivial total savings in Medicare costs, and improved

incentives, could probably follow from a restructuring of at least some diagnostic test prices.

Table 1
COST INFORMATION BY HCPCS CODES

| | Name of Equipment | Purchase Price | | Est. Useful Life | % Utiliz This Proc. |
|---|---|---|---|---|---|
| SPIROMETRY<br>94010-Spirometry | automated spirometer with microprocessor | Non-Spec<br>Spec | $4,000<br>$8,000 | 5 years | Non-Spec 90%<br>Spec 30% |
| OPHTHALMIC BIOMETRY BY ULTRASOUND<br>76516-echography, A-mode | A-Mode ophthalmic scanner | Spec Low<br>Spec High | $6,250<br>$12,000 | 5 years | Spec. 70-90% |
| ABDOMINAL ECHOGRAPHY<br>76700-B scan or real time<br>76705-single organ, quadrant, follow up | real time abdominal scanner | Non-Spec Low<br>Non-Spec High<br>Spec Low<br>Spec High | $20,000<br>$30,000<br>$65,000<br>$85,000 | 5 years | Non-Spec 60%<br>Spec 40% |
| PERIPHERAL VASCULAR<br>93910-Artery, Lower | noninvasive ultrasonic vascular assessment system | Non-Spec Low<br>Non-Spec High<br>Spec Low<br>Spec High | $5,000<br>$7,000<br>$70,000<br>$90,000 | 5 years | Non-Spec 30%<br>Spec 60% |
| CHEST & ORTHOPEDIC X-RAYS<br>71010-single view, frontal<br>71020-frontal & lateral<br>72170-Pelvis, anterop osterior<br>73020-Shoulder, one view<br>73510-Hip, complete, min 2<br>73560-Knee anteposs. & lateral<br>73620-Foot, anteposr & lateral | non-fluroscopic x-ray machine | Non-Spec Low<br>Non-Spec High<br>Spec Low<br>Spec High | $50,000<br>$60,000<br>$90,000<br>$100,000 | 10 years | 10.0%<br>20.0%<br>4.5%<br>6.8%<br>15.1%<br>12.9%<br>10.7% |
| UPPER G.I.<br>74240-w or w/o delayed film, w/o KUB | fluoroscopic x-ray machine | Spec Low<br>Spec High | $150,000<br>$200,000 | 10 years | Spec 50% |
| CT SCAN OF HEAD OR BRAIN<br>70470-Head w/o then w contrast | whole body CT scanner | Spec Low<br>Spec High | $500,000<br>$800,000 | 7 years | Spec 60% |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Tape | holter analog recorder | Low<br>High | 1000-1200<br>1800-2100 | 5-7 years | 100% |
| SUPERIMPOSITION SCANNING & RPT<br>93262 (Q0021) Tape Scanning | holter scanner | Low<br>High | 30,000-35,000<br>55,000-60,000 | 6-10 years | 100% |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Chip | holter digital recorder | Low<br>High | 10,000-12,000<br>18,000-22,000 | 4-6 years | 100% |
| COMPUTER ANALYSIS & REPORT<br>93262 (Q0021) From Chip Memory | personal computer, software, printer | Low<br>High | 500<br>5000 | 5-8 years | 25-100% |
| REAL TIME ANALYSIS<br>93266 (Q0028) | real time monitor | Low<br>High | 5000-6000<br>8000-12,000 | 4-6 years | 100% |
| ELECTROCARDIOGRAM<br>93005 12 Lead EKG hookup/disc | electrocardiograph 12 lead | Low<br>High | 4000<br>13,000 | 8-12 years | 100% |

Table 1 (cont.)
COST INFORMATION BY HCPCS CODES

| | VOLUME/YEAR | | Maintenance cost/year | | Time/ procedure | Type of Employee Performing Service | |
|---|---|---|---|---|---|---|---|
| SPIROMETRY<br>94010-Spirometry | Non-Spec Low Cost<br>Non-Spec High Cost<br>Spec Low Cost<br>Spec High Cost | 400<br>100<br>1000<br>500 | Low<br>High | 2.5%<br>5.0% | .33 hours | Non-Spec<br>Spec | Low skill tech<br>Low skill tech |
| OPHTHALMIC BIOMETRY BY ULTRA<br>76516-echography, A-mode | Spec Low Cost<br>Spec High Cost | 150<br>150 | Low<br>High | 3.5%<br>7.0% | .25 hours | Spec | High skill tech |
| ABDOMINAL ECHOGRAPHY<br>76700-B scan or real time<br>76705-single organ, quadrant, follow up | Non-Spec Low Cost<br>Non-Spec High Cost<br>Spec Low Cost<br>Spec High Cost | 500<br>150<br>1000<br>5000 | Low<br>High | 4.0%<br>8.0% | .67 hours | Non-Spec<br>Spec | Low skill tech<br>High skill tech |
| PERIPHERAL VASCULAR<br>93910-Artery, Lower | Non-Spec Low Cost<br>Non-Spec High Cost<br>Spec Low Cost<br>Spec High Cost | 300<br>150<br>1300<br>500 | Low<br>High | 3.5%<br>7.0% | .5 hours | Non-Spec<br>Spec | Low skill tech<br>High skill tech |
| CHEST & ORTHOPEDIC X-RAYS<br>71010-single view, frontal<br>71020-frontal & lateral<br>72170-Pelvis, anteroposterior<br>73020-Shoulder, one view<br>73510-Hip, complete, min 2<br>73560-Knee antepost. & lateral<br>73620-Foot, antepost & lateral | Non-Spec / Spec<br>142 / 210<br>283 / 428<br>8 / 71<br>11 / 106<br>22 / 200<br>18 / 166 | | Low<br>High | 5.0%<br>10.0% | .33 hours<br>.42<br>.33<br>.33<br>.42<br>.42<br>.42 | Non-Spec<br>Spec | Low skill tech<br>High skill tech |
| UPPER G.I.<br>74240-w or w/o delayed film, w/o KUB | Non-Spec / Spec<br>333 / 333 | | Low<br>High | 5.0%<br>10.0% | .5 hour | Spec | High skill tech |
| CT SCAN OF HEAD OR BRAIN<br>70470-Head w/o then w contrast | Spec Low Cost<br>Spec High Cost | 1560<br>1000 | Low<br>High | 7.5%<br>10.0% | .66 hours | Spec | High skill tech |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Tape | 250 maximum | | 5-10% Service Cont. | | .75 hours | Tech/Nurse/Office | |
| SUPERIMPOSITION SCANNING & RPT<br>93262 (Q0021) Tape Scanning | 8/day maximum commonly much lower | | 5-10% Service Cont. | | 1 hour | Tech/Nurse | |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Chip | 250 maximum | | 5-10% Service Cont. | | .75 hour | Tech/Nurse/Office | |
| COMPUTER ANALYSIS & REPORT<br>93262 (Q0021) From Chip Memory | 8/day maximum commonly much lower | | 5-10% Service Cont. | | 25 hour | Tech/Nurse/Office | |
| REAL TIME ANALYSIS<br>93296 (Q0028) | 250 maximum | | 5-10% service contract | | .75 hour<br>High 10 12 mins | Tech/Nurse/Office | |
| ELECTROCARDIOGRAM<br>93005 12 Lead EKG hookup/disc | 170-850 | | 5-10% service contract | | Low 3.5 mins<br>High 10 12 mins | Nurse/Tech | |

Table 1 (cont.)
COST INFORMATION BY HCPCS CODES

| | Hourly Wage | Supplies/ procedure |
|---|---|---|
| SPIROMETRY<br>94010-Spirometry | 10.62/hour | Low Cost<br>High Cost |
| OPHTHALMIC BIOMETRY BY ULTRA<br>76516-echography, A-mode | 16.04/hour | Low Cost<br>High Cost |
| ABDOMINAL ECHOGRAPHY<br>76700-B scan or real time<br>76705-single organ, quadrant, follow up | 10.52/hour<br>16.04/hour | Low Cost<br>High Cost |
| PERIPHERAL VASCULAR<br>93910-Artery, Lower | 10.52/hour<br>16.04/hour | Low Cost<br>High Cost |
| CHEST & ORTHOPEDIC X-RAYS<br>71010-single view, frontal<br>71020-frontal & lateral<br>72170-Pelvis, anteroposterior<br>73020-Shoulder, one view<br>73510-Hip, complete, min 2<br>73560-Knee antepost. & lateral<br>73620-Foot, antepost & lateral | 10.52/hour<br>16.04/hour | Low<br>3.75<br>5.50<br>3.75<br>3.75<br>5.50<br>5.50<br>5.50 |
| UPPER G.I.<br>74240-w or w/o delayed film, w/o KUB | 16.04/hour | Low Cost<br>High Cost |
| CT SCAN OF HEAD OR BRAIN<br>70470-Head w/o then w contrast | 16.04/hour | Low Cost<br>High Cost |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Tape | Low 10/hour<br>High 16/hour | $9-11 |
| SUPERIMPOSITION SCANNING & RPT<br>93262 (Q0021) Tape Scanning | Low 10/hour<br>High 16/hour | $2 |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Chip | Low 10/hour<br>High 16/hour | $9-11 |
| COMPUTER ANALYSIS & REPORT<br>93262 (Q0021) From Chip Memory | Low 8/hour<br>High 16/hour | $1-2 |
| REAL TIME ANALYSIS<br>93266 (Q0028) | Low 10/hour<br>High 16/hour | $5 |

SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|
| CODE: 94010<br>DESCRIPTION: SPIROMETRY | | | | | | | |
| Non-specialist low | 100 | 15.59 | | Int. Med. 22.79 | 52.9 | Procedures | 13.23 - 19.53 |
| Non-specialist high | 100 | 20.17 | | | 165 | | |
| | | | 24.14 | | | | |
| Specialist low | 1000 | 4.54 | | | 34 | | |
| Specialist high | 500 | 7.27 | | Pulm. Dis. 23.75 | 43.4 | Oper. Exp. | 5.80 - 8.74 |
| CODE: 76516 (3)<br>DESCRIPTION: OPHTH.BIOMETRY | | | | | | | |
| Non-specialist low | | | | | | | |
| Non-specialist high | | | | | | | |
| | | | 45.75 | | | | |
| Specialist low | 150 | 16.56 | | Ophth. 40.26 | 26.2 | Procedures | 14.06 - 20.73 |
| Specialist high | 150 | 32.96 | | | 60.5 | Procedures | 27.19 - 42.58 |
| CODE: 76700<br>DESCRIPTION: ULTRASOUND | | | | | | | |
| Non-specialist low | 500 | 15.42 | | Int. Med. 86.12 | 38.1 | Oper. Exp. | 12.78 - 18.07 |
| Non-specialist high | 150 | 48.28 | | | 75 | | |
| | | | 77.03 | | | | |
| Specialist low | 1000 | 19.43 | | | 84 | | |
| Specialist high | 500 | 33.47 | | Rad. 73.97 | 135.3 | Procedures | 29.52 - 40.04 |
| CODE: 93910<br>DESCRIPTION: NON-INV PER VASCULAR | | | | | | | |
| Non-specialist low | 300 | 10.62 | | Int. Med. 79.90 | 15 | Oper. Exp. | 8.69 - 12.55 |
| Non-specialist high | 150 | 22.71 | | | 32.7 | | |
| | | | 68.88 | | | | |
| Specialist low | 1300 | 13.74 | | | 75 | | |
| Specialist high | 500 | 25.97 | | Gen. Surg. 56.55 | 117.6 | Procedures | 22.98 - 30.95 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non specialist"
(3) In April 1988, the allowed charge for ophthalmic biometry was restricted to 5% of the average allowed charge for cataract removal, HCPCS Code 66984

Table 2 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|---|
| CODE: 71010<br>DESCRIPTION: CHEST X-RAY 1 VIEW | | | | | | | | |
| Non-specialist low | 142 | 13.72 | | Int. Med. | 19 | 97.72 | Oper. Exp. | 11.12 - 16.33 |
| Non-specialist high | 142 | 18.8 | | | | 177.5 | | |
| | | | 15.19 | | | | | |
| Specialist low | 210 | 16.5 | | | | 205.3 | | |
| Specialist high | 210 | 21.32 | | Rad. | 9.86 | 376 | Oper. Exp. | 17.10 - 25.53 |
| CODE: 71020<br>DESCRIPTION: CHEST X-RAY 2 VIEWS | | | | | | | | |
| Non-specialist low | 283 | 13.18 | | Int. Med. | 24.28 | 60.8 | Oper. Exp. | 10.30 - 16.06 |
| Non-specialist high | 283 | 19.57 | | | | 131.8 | | |
| | | | 22.62 | | | | | |
| Specialist low | 428 | 19.81 | | | | 177.8 | | |
| Specialist high | 428 | 25.12 | | Rad. | 23.67 | 428.5 | Oper. Exp. | 19.95 - 30.30 |
| CODE: 72170<br>DESCRIPTION: PELVIS X-RAY | | | | | | | | |
| Non-specialist low | 8 | 58.97 | | Int. Med. | 20.23 | 31.1 | Procedures | 48.62 - 76.18 |
| Non-specialist high | 8 | 85.62 | | | | 53 | | |
| | | | 19.27 | | | | | |
| Specialist low | 71 | 20.37 | | Ortho. | 17.71 | 69.9 | | |
| Specialist high | 71 | 26.19 | | Rad. | 21.42 | 119.5 | Oper. Exp. | 21.12 - 31.27 |
| CODE: 73510<br>DESCRIPTION: HIP X-RAY | | | | | | | | |
| Non-specialist low | 25 | 65.89 | | Int. Med. | 26.52 | 86.8 | Procedures | 54.70 - 84.54 |
| Non-specialist high | 25 | 95.22 | | | | 152.1 | | |
| | | | 22.82 | | | | | |
| Specialist low | 235 | 22.34 | | Ortho. | 19.56 | 172.1 | | |
| Specialist high | 235 | 28.96 | | Rad. | 25.80 | 82.8 | Oper. Exp. | 23.25 - 34.71 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 2 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|---|
| CODE: 73020<br>DESCRIPTION: SHOULDER X-RAY | | | | | | | | |
| Non-specialist low | 11 | 64.18 | | Int. Med. | 23.06 | N.A. | Procedures | 52.78 - 83.14 |
| Non-specialist high | 11 | 93.90 | | | | N.A. | | |
| | | | 20.51 | | | | | |
| Specialist low | 106 | 19.06 | | Ortho. | 19.11 | N.A. | | |
| Specialist high | 106 | 24.94 | | Rad. | 22.65 | N.A. | Procedures | 22.11 - 29.66 |
| CODE: 73560<br>DESCRIPTION: KNEE X-RAY | | | | | | | | |
| Non-specialist low | 22 | 64.17 | | Int. Med. | 22.09 | 99.2 | Procedures | 53.32 - 82.25 |
| Non-specialist high | 22 | 92.70 | | | | 182 | | |
| | | | 19.78 | | | | | |
| Specialist low | 200 | 22.36 | | Ortho. | 19.16 | 208 | | |
| Specialist high | 200 | 29.01 | | Rad. | 21.76 | 395.8 | Oper. Exp. | 23.26 - 34.75 |
| CODE: 73620<br>DESCRIPTION: FOOT X-RAY | | | | | | | | |
| Non-specialist low | 18 | 64.84 | | | | | Oper. Exp. | 55.58 - 74.08 |
| Non-specialist high | 18 | 93.70 | | | | | | |
| | | | 17.85 | | | | | |
| Specialist low | 166 | 22.34 | | Ortho. | 16.61 | | | |
| Specialist high | 166 | 26.99 | | Rad. | 19.33 | | Oper. Exp. | 23.25 - 34.72 |
| CODE: 74240<br>DESCRIPTION: UPPER G.I X-RAY | | | | | | | | |
| Non-specialist low | | | | | | | | |
| Non-specialist high | | | | | | | | |
| | | | 57.45 | | | | | |
| Specialist low | 333 | 57.21 | | | | 293.6 | Procedures | 49.77 - 69.61 |
| Specialist high | 333 | 82.64 | | Rad. | 59.64 | 506.8 | Procedures | 70.72 - 102.52 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 2 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|
| CODE: 70470<br>DESCRIPTION: C.T. SCAN | | | | | | | |
| Non-specialist low | | | | | | | |
| Non-specialist high | | | | | | | |
| | | | 210.24 | | | | |
| Specialist low | 1560 | 129 | | | 503.2 | Oper. Exp. | 104.10 - 153.91 |
| Specialist high | 1000 | 223.77 | | Rad. 207.10 | 966.8 | Procedures | 198.42 - 266.02 |
| CODE: 93262 (Q0020)<br>DESCRIPTION: HOLTER ANALOG RECORDING | | | | | | | |
| Non-specialist low | 150 | 19.35 | | N.A. | 7 | Oper. Exp. | 14.85 - 23.85 |
| Non-specialist high | 50 | 25.99 | | | 11 | | |
| | | | 50.38 | | | | |
| Specialist low | 250 | 22.83 | | | 13 | | |
| Specialist high | 180 | 27.07 | | N.A. | 23 | Oper. Exp. | 21.02 - 33.10 |
| CODE: 93262 (Q0021)<br>DESCRIPTION: HOLTER ANALOG SCANNING | | | | | | | |
| Non-specialist low | 500 | 23.03 | | N.A. | 48 | Oper. Exp. | 19.15 - 26.90 |
| Non-specialist high | 200 | 58.54 | | | 78 | | |
| | | | 116.30 | | | | |
| Specialist low | 400 | 36.92 | | | 87 | | |
| Specialist high | 200 | 122.36 | | N.A. | 193 | Volume | 101.49 - 157.13 |
| CODE: 93262 (Q0020)<br>DESCRIPTION: DIGITAL HOLTER RECORDING | | | | | | | |
| Non-specialist low | 150 | 26.84 | | N.A. | 56 | Volume | 23.50 - 32.42 |
| Non-specialist high | 50 | 94.20 | | | 97 | | |
| | | | 50.38 | | | | |
| Specialist low | 250 | 30.74 | | | 108 | | |
| Specialist high | 180 | 64.65 | | N.A. | 228 | Volume | 55.12 - 80.5 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 2 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|
| CODE: 93262 (Q0021)<br>DESCRIPTION: DIGITAL HOLTER SCANNING | | | | | | | |
| Non-specialist low | 500 | 3.48 | | N.A. | 1 | Oper. Exp. | 2.85 - 4.36 |
| Non-specialist high | 200 | 5.78 | | | 3 | | |
| | | | 116.30 | | | | |
| Specialist low | 400 | 3.71 | | | 1 | | |
| Specialist high | 200 | 14.28 | | N.A. | 17 | Volume | 12.24 - 17.64 |
| CODE: 93266 (Q0028)<br>DESCRIPTION: REAL TIME ANALYSIS | | | | | | | |
| Non-specialist low | 150 | 18.48 | | N.A. | 16 | Volume | 16.81 - 21.27 |
| Non-specialist high | 50 | 56.84 | | | 29 | | |
| | | | 119.05 | | | | |
| Specialist low | 150 | 25.91 | | | 25 | | |
| Specialist high | 50 | 94.2 | | N.A. | 53 | Volume | 77.90 - 121.37 |
| CODE: 93005<br>DESCRIPTION: ELECTROCARDIOGRAM, TRACING ONLY | | | | | | | |
| Non-specialist low | 425 | 8.17 | | | 212 | Oper. Exp. | 6.43 - 9.92 |
| Non-specialist high | 170 | 14.63 | | | 379 | | |
| | | | 9.26 | N.A. | | | |
| Specialist low | 850 | 9.27 | | | 761 | | |
| Specialist high | 700 | 13.92 | | | 2955 | | 11.36 - 16.47 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

# CHAPTER 1: INTRODUCTION

## BACKGROUND

Use of laboratory tests and diagnostic tests is growing and is believed to be an important factor in the growth of Part B program costs.

Concerned that this increase was being transferred to beneficiaries in the form of increased cost sharing, Congress has enacted several changes in the methods used to pay for tests. Fee schedules and direct billing for clinical laboratory tests performed outside the physician's office were addressed by the Deficit Reduction Act of 1984 (DEFRA): the ordering physician's markup was limited to $3 over acquisition cost and the outside laboratory's claim was subjected to mandatory assignment. Effective January 1, 1987 clinical lab services performed in the physician's office are subjected to mandatory assignment as a result of the 1986 Consolidated Omnibus Budget Reconciliation Act (COBRA).

Non-clinical laboratory diagnostic tests such as X-rays, EKGs, EEGs, cardiac monitoring and ultrasound, in contrast, were not addressed until recently. In April 1988, the Omnibus Budget Reconciliation Act of 1987 (OBRA-87) became effective changing billing rules for diagnostic tests purchased from outside suppliers. Section 4051 of the new law discontinues global billing for purchased tests. The physician must separately itemize his own professional interpretation component from the purchased technical component and identify the supplier and net purchase charge paid. The carrier then limits the technical component charge to the lower of the supplier's net charge, the supplier's usual direct billing charge, or the physician's actual

charge. In effect, the physician cannot mark-up the technical component, but he may bill for the component.

At this time policy for determining payment levels for diagnostic tests performed in the physicians' office is unresolved. The OBRA-87 directed the Secretary of Health and Human Services to review payment levels for in-office diagnostic tests and reduce payments as appropriate.

Our study responds to the mandates of OBRA-87 by investigating methods to evaluate charges, both global and technical, for diagnostic tests. In addition, we provided a comparison of HCFA payments for these tests with those of large HMOs. We analyzed variation in payment for diagnostic tests in the BMAD file. We looked at the global fees and at the professional and technical components and assessed variations in Medicare payments by physician specialty, locality and other variables. Finally, we examined the use of a net present value (NPV) approach for determining payment for the technical component of tests. This approach is intended to set the price to yield a return on physician investments in equipment no greater than the market or "normal" return.

We explored the desirability and feasibility of a volume-related payment system, one which makes the unit price a doctor receives conditional on the volume of tests per machine or per practice. Higher payment levels may stimulate the volume of tests by offering a financial incentive for over-provision of services to those physicians for whom the price exceeds marginal cost. Thus the Medicare program costs may grow due both to high reimbursement per test and over-utilization of the tests. Evaluation of the appropriateness of payment levels for diagnostic tests is one aspect of the physician payment reform. Readjustment in payment methods and levels have cost containment

goals and goals regarding payments among specialties, regions and beneficiaries that are perceived to be equitable. In the case of diagnostic tests (or other services produced with heavy fixed costs), such goals cannot be achieved by a system which pays one fixed price; instead, ideal prices in a given geographic area may be ones which vary with test volume.

We address the following issues:

- Analysis of BMAD data for a set of high volume diagnostic tests to assess billing methods and variation in payments. We identified a set of relevant diagnostic tests, and determined their global and professional fees. The implied technical component of the price for each test was estimated by comparing that test's mean charges for services billed globally with those billed for professional services only; this "technical differential" is the additional revenue physicians would receive, on average, if they produced the test themselves. This differential was examined at the national level, within regions, within carrier areas, and across specialties.
- Analysis of methods and criteria for determining appropriateness of payment levels for the technical component of diagnostic tests.
- Comparison of mean medical global and technical fees with payment levels set by private sector IPA-type organizations.
- Evaluation of the desirability and feasibility of using pricing of the technical component based on the rate of return on investment to determine a reasonable price for the technical component.
- Evaluation of current charges for the implicit technical component of high volume diagnostic tests based on a net present value approach.

- An analysis of the current pricing and determination of reasonable charges for Real time and Holter monitors.

OBJECTIVE

This study is intended to develop methods for evaluating Medicare reasonable charges for diagnostic tests other than laboratory tests provided by physicians in their offices. The methods will help to determine whether current charge levels are reasonable, and, if not, how such reasonable levels can be determined.

THE MEANING OF "APPROPRIATE CHARGE"

From an economic perspective, the most fundamental definition of an appropriate charge/reimbursement for diagnostic tests is a level just sufficient to induce doctors to make appropriate volumes of tests of appropriate quality available to beneficiaries. In order to answer the question of how to determine this price, we first investigate the question of the ways in which diagnostic tests differ from other physician provided services.

One approach to answering this question is to imagine that physician-provided services can be arrayed along a (two-dimensional) spectrum involving both the relative amounts of capital and labor used and the need for the patient to be present. At one end of the spectrum, the initial diagnostic visit requires the patient to be present, and uses a large amount of physician time relative to capital. At the other end of the spectrum, a clinical laboratory test requires neither physician time nor the presence of the patient, once the specimen has been drawn, but does require capital equipment. The non-laboratory diagnostic tests studied in this report do require the

patient to be present, but typically use little physician time and sizeable amounts of specialized capital, relative to other inputs.

In this sense, diagnostic tests fall between the other two categories in the ability to be disconnected from doctor or patient. There is variation, of course, across types of diagnostic tests. A peripheral vascular test would involve more patient and physician time than would an EKG. But the kinds of tests we will evaluate in this study are ones which do not require (though they may use) physician time, but do require the patient to be present and do use relatively large amounts of capital.

Thus, one important difference is that such tests are much more capital intensive than other physician-provided services, and this observation suggests that examining rates of return on capital invested in the equipment used to provide the tests may help in determining the reasonableness of prices. The feasibility and effects of using a return on investment (ROI) approach is yet to be determined.

Compared to the clinical laboratory tests, it would be more costly to "batch" diagnostic tests, or to furnish them in a large facility designed to reap economies of scale, since either strategy will involve time and inconvenience costs on the beneficiary/patient. Over some range, there is likely to be a tradeoff between explicit costs of diagnostic tests (which Medicare must cover) and "access," measured as implicit patient time and inconvenience costs. It is more difficult, one suspects, to maintain access and get lower prices through economies of scale for diagnostic tests (for which the patient must be transported) than for clinical lab tests (where only specimens need to be transported). There can be quality/accuracy benefits for greater volumes that can offset patient costs; nevertheless, the question of the level of

access to be offered (in terms of the amount of time and inconvenience cost to be imposed on beneficiaries) will be important in this inquiry to a much greater extent than would be true of lab tests.

These differences across types of Medicare services are important for thinking about the basis of payments for diagnostic tests and possible ways to determine appropriate payment levels.

For services which require the physician to be present, proper pricing is likely to require consideration of the value of physician time (in dollars), a daunting task. For services for which neither the physician nor the patient need to be present, competitive bidding, well-known to be a way to set prices close to cost without prior knowledge of the level of cost, is probably feasible. In the case of physician-provided diagnostic tests, where capital is an important input and physician time is not, it may be possible to determine an appropriate price by focussing on the return on capital. For those tests for which doctor time is important, the methods we will be considering here will not be as appropriate.

## CHAPTER 2: ANALYSIS OF MEAN CHARGE VARIATION IN BMAD DATA FOR DIAGNOSTIC TESTS

### SELECTING TESTS TO BE STUDIED

We identified several criteria for choosing the diagnostic tests to be examined. The six criteria for choosing tests were:

- cost of production
- Medicare volume of the test, in both physical and cost terms
- perceived appropriateness of current level of utilization
- patient accessibility
- the number of specialties performing the test
- perceived profit margin

Approximately 20 clinicians in the Philadelphia area were asked for their opinion about thirty diagnostic tests according to these criteria. Each test was to be scored as low, medium, or high on each of the criteria. The clinicians were asked to consider the situation in the United States as a whole, rather than in their own practice or geographical area. Based on responses received, the following 11 procedures were selected for study.

1. Chest X-ray: This is a high volume test with a low cost of production. It is performed by several specialties, indicating possible pricing differences among specialists. It is also of interest to HCFA. In the analysis, we distinguish between single view and multiple views procedures.
2. Routine EKG: It is considered to have high volume, a low cost of production and is sometimes said to be over-utilized. This test also is

of interest to HCFA. For this test only there are separate HCPCS codes for a global service, tracing (technical component), and professional services.

3. 24-hour Holter monitor. This test has a medium volume of use and medium cost of production. It was considered by respondents to be a high profit test. Its association with real-time EKG monitoring is of interest to HCFA and would be important to analyze.

4. Real-time EKG Monitoring: This test was selected for study primarily because of recent controversy over reimbursement which is of interest to HCFA. It was perceived by the respondents to be a high-profit test.

5. Peripheral Vascular Studies: This group of tests was chosen because HCFA's interest in them and because they are performed by several specialties.

6. Spirometry: This is a low-cost, high volume test which is of interest to HCFA.

7. CT of the Head or Brain: This is a high cost, high volume test on which there seems to be a range of assessments concerning the appropriateness of current utilization levels.

8. Orthopedic X-rays: This category includes several tests that were assessed similarly by the respondents: low cost, medium to high volume and medium profit margins. These tests can be done using the same equipment and, therefore, it would be interesting to explore pricing differences and strategies between various types of orthopedic X-rays.

9. Upper Gastrointestinal X-ray: Opinions about appropriateness of utilization of this test are divided. Further, it is a test that is being replaced by upper GI endoscopy, which was identified as increasing in

volume. Therefore, pricing considerations are interesting to consider. This test uses a different type of X-ray equipment from that used for other X-rays.

10. Ophthalmic Biometry by Ultrasound: This test was selected because it is associated with high volume surgical procedures: cataract removal and lens insertion. It represents an ultrasound procedure which is of interest to HCFA and which has recently been subjected to a pricing change.

11. Echography (abdominal ultrasound): This is a medium cost, high volume test, with a perceived high profit margin.

Some of these tests are described by several different HCPCS codes, reflecting minor variations in the services provided. In the data analysis which follows, we aggregate across the sets of codes shown in Table 3 below. We have also performed each analysis using only the single most common test code in each set, and found virtually no difference in results. This similarity of results occurs because one code usually has much greater frequency than the other codes in the set and because the ratio of various subtypes of tests varies little. Consequently, even though some HCPCS codes do represent versions of a test with different levels of inputs to the technical component, it is still appropriate to aggregate.

## METHODS OF BILLING

Although in principle it is possible for office physicians to bill and be paid separately only for the technical (non-professional) component of each of these tests, preliminary analysis indicated that this practice is quite rare for tests performed in doctors' offices, at least as the practice is reflected

Table 3

**PROCEDURES EXAMINED AND THEIR HCPCS CODES**

| TEST | HCPCS CODES |
|---|---|
| Chest X-ray - single view | 71010, 71015 |
| Chest X-ray - two views | 71020, 71021, 71022, 71023, 71030, 71034, 71035 |
| Routine EKG with interpretation and report | 93000 |
| Holter monitor | 93258, 93259, 93262, 93263 |
| Real time EKG monitor | 93266 |
| Spirometry | 94010, 94060, 94070 |
| Non-invasive peripheral vascular | 93850, 93860, 93890, 93910, 93950, 93960 |
| Pelvis X-ray | 72170, 72180, 72190 |
| Shoulder X-ray | 73020, 73030 |
| Hip X-ray | 73500, 73510, 73520 |
| Knee X-ray | 73560, 73562, 73564 |
| Foot X-ray | 73620, 73630 |
| Ophthalmic Biometry by ultrasound-bilateral | 76516 |
| CT of head and brain | 70450, 70460, 70470 |
| Echography (complete abdominal ultrasound) | 76700, 76705 |
| Upper GI X-ray | 74240, 74241, 74245 |

in the "modifier" codes attached by carriers. (Only EKGs have separate HCPCS codes for professional and technical components.) We therefore were unable to examine the explicit charges for professional services only in the office and explicit charges for the office technical component. Instead, we infer what the implicit average payment is for the technical component by subtracting the average fee when Medicare is billed for a test performed in the hospital from the average charge for a global fee ("no relevant modifier") for office tests. The few cases (less than one percent) in which the modifier indicated that the charge was for technical services only in the office have been excluded.

We have classified procedures by their code and by the presence or absence of "relevant modifiers." If a "26" modifier is present, that means that the claim is for professional services only. There are some other codes which, though rare, are "relevant" modifiers in the sense that they are likely

to affect prices. These include codes for "technical component only," or for "reduced fee." After deleting the few observations on this list, we are left with charges for services delivered with no relevant modifier.* These are the regular price global fees with which we are concerned.

In principle the relevant measure to compare with a global fee for services provided in the office would be the fee for professional services only provided in the office. For most of the tests, however, this event is fairly rare--virtually all office services are billed globally. We instead subtract the mean charge where the place of services is "hospital," on the assumption that the professional services themselves are the same in either place if the test is the same. As will be shown, in the few cases when there is a reasonable sample of "professional services only" bills with office as the site, the mean charge for professional services only is virtually identical whether the place is "office" or "hospital". In the hospital as well, a charge can be coded as "professional fee only" or have no such modifier. But in this setting, the charge ought to be the same regardless of whether it is explicitly a professional charge or not, because doctors are not allowed to charge for the technical component furnished by a hospital.

We call the difference between the office global fee and the hospital fee the "technical differential". We provide two alternative measures of the differential. Differential D1 is the difference between the global fee for procedures in office and the fee for procedures performed in hospitals for which there is no professional modifier. Differential D2 is the difference between the global fee for procedures in the office and the professional

* The other relevant modifiers are 27, 28, 51, 52, TC, WA, WB, WC, or WD.

services only fee for services rendered in the hospital. In general, the two values are close, but there are sometimes some differences; we explore this issue further below.

The BMAD file we examined provides, by pricing locality, tabulations of the frequency of each procedure and aggregate allowed charges. From this information a mean allowed charge per service can be calculated. Note that the data is not at the level of the individual physician, so that questions of the uniqueness of billing numbers will not arise. However, the data in this form provides no way of calculating the variation in allowed charges across individual physicians.

This data gives an estimate of the additional amount that could be charged when a doctor acquired the capability of performing the technical component. Conceptually, it represents the amount of revenue a doctor would lose if a hospital was used as the test site. If this estimated technical component calculated as the difference between office global and hospital fees (either professional or unmodified), is high relative to some standard, this result could either mean that the global fee is too high relative to the (hospital) professional fee (that is, that the additional technical component is too large), or that the professional fee is too low. Particularly when the frequency of either office or hospital test production is low relative to the use of the other site, results should be interpreted cautiously.

## VARIATION IN MEAN CHARGES AND MEAN TECHNICAL DIFFERENTIALS

There are several dimensions over which charges might vary. One possibility is that charges, and the technical differential, might vary across specialty. We therefore show national mean charges by specialty for the four

specialties (other than miscellaneous) with the largest frequencies of office testing. We also show the mean charges for "clinic, group practice", code 70 in HCFA's Specialty Codes, when it is not among the four with the largest frequency. This code represents multi-specialty groups only, while the one-specialty groups and the single practitioners appear in the specific specialty category. Next, we illustrate how charges vary across the country by displaying mean charges for the top two specialties for each of the HCFA regions. Finally, we illustrate the within-region and within-plan variation, the kind of variation doctors would confront if they moved within their state or region, by calculating standard deviations and coefficients of variation for the deviation between pricing locality means and carrier means.

1. Cross-Specialty Variation in Charges and Technical Components

Table 2-1 in Appendix A shows mean nationwide charges calculated from the 1986 BMAD procedure file for each test for the four specialties with the highest office global fee volume. Where it is not one of the top four, we have also included values for physicians who practice in a multi-specialty group or clinic.

We will comment on the D2 differential, the difference between the office global fee, and the hospital professional only. (The results for the D1 differential are similar.) Several results here are of interest. First, there are some tests for which office charges, hospital charges, and technical component differentials for a given procedure are virtually identical across specialties. For instance, bilateral chest X-ray exhibits differentials (global office less hospital professional only) which range only from $21 to $24. In percentage terms, there is also little variation in the technical

differential for CT scan of the head, for Holter monitoring, and for upper GI X-ray. Whether these prices are appropriate or not, at least they are uniform across specialties. The differentials vary little because the mean global office charges and mean hospital charges vary little.

For most of the tests, however, the pattern is one in which charges and differentials for three out of four are quite close, but one specialty is outside the range. For instance, for all of the orthopedic X-rays the differential for orthopedic surgeons is unusually low, but the level for the other specialties is approximately the same. (For all orthopedic X-rays, the implied charge for the technical component was approximately $20.00 per test). The orthopedic differential is low because the orthopedic charge when a hospital is the site is higher. Many other tests show this same pattern. In the case of chest X-ray, one side, radiology is a lower outlier, while family practice is low for EKGs. There is a relatively high technical component differential for one specialty for spirometry (general practice), and non-invasive peripheral vascular (cardiovascular). Two tests, ophthalmic biometry and real-time EKG show substantial variation across all specialties. However, in the former case the volume is quite low for all other specialties and in the latter case the test is quite new. The pattern is much the same when the other measure of hospital charges is used.

The overall impression is that there is not an enormous amount of cross-specialty variation in either mean charges or the implied mean price for the technical component for most tests. Differentials have low variation because office global fees and hospital fees display low variation. There are some outlier specialties for some of the tests, but generally mean prices are fairly close together. Moreover, all orthopedic X-rays appear, as one might

expect, to show about the same technical component price. There are, however, some tests that do display fairly substantial cross-specialty variation. One test is new (real-time EKG); the other (ophthalmic biometry) has low volumes for specialties other than ophthalmology.

2. Regional Variation

If mean charges levels and mean differentials do not vary enormously across specialty, do they vary across regions of the country or within carrier region across pricing localities? Table 2-2 in Appendix A shows mean charges by HCFA region for each test for the two specialties with the highest frequency of office tests billed as a global (no relevant modifier) fee.

The technical differential displays some variation, across regions, with the variation generally being smaller when the test is done at the office or hospital with equal frequency. For example, the variation in the differential for bilateral X-ray by radiologists is quite small; this is also generally the case for radiologists' billing of orthopedic x-rays. But in other cases, especially when the hospital site is less common, there can be important variation in the differential. For internists, spirometry mean differentials range from $6 in the Denver region to $19 in the Philadelphia region. The technical component for vascular tests varies from $6 in Boston or Denver to $75 in Chicago. The main reason for the variation is usually variation across regions in the hospital charges, not variation across regions in the global office fee.

There is no consistent pattern of one carrier being lowest or highest for all or most tests. Chicago, for example, is highest for some tests (spirometry, IM), but lowest for others (CAT scan, radiology).

It appears that there is small regional variation in charges for a global office service. In contrast, the differential is in general quite variable across regions due to variation in hospital charges.

3. Variation Across Carriers

The number of carriers is too large to show values for mean charges by test by specialty in a single table. Tables 2-3 in Appendix A show the coefficients of variation of the carrier mean relative to the national mean for each of the four charge measures.** In this sense, it is the same as a conventional coefficient of variation of a variable about its mean. The coefficient of variation (CV) here is based on unweighted deviations of each carrier's mean charge from the national mean charge. The coefficient of variation of the differential is also presented. Since some carriers apparently require all hospital billing to take only one form, some of the hospital charges (and the implied technical component differential based on them) have low or zero frequency. Accordingly, we have deleted any differential for which there is not at least a frequency of 100 for office charges and each of the hospital comparisons.

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**The coefficient of variation is the square root of the sum of the squared deviations of the carrier mean relative to the national mean divided by the national mean.

$$\text{coefficient of variation} = \frac{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}}{\bar{X}}$$

$X_i$ - carrier's mean charge
$\bar{X}$ - national mean charge
n - number of carriers

The CV for the global fee mean is fairly large. And because the hospital charges may vary somewhat more, the CV for the technical differential is even larger. The CV is generally smaller for X-ray procedures than for others, but there is still substantial variation.

At HCFA's request, we have also examined the patterns of mean charges for hospital services. Although a hospital charge can either be paid with a modifier for "professional services only" or with no modifier, the same price should be paid in either case, since there is no technical component cost to be covered by Part B. But do all carriers actually observe this procedure?

Table 4 lists by specialty all cases in which a carrier made payment for more than 500 tests under each version of hospital charge coding. In the great majority of carriers, payment is entirely or almost entirely classified either as professional services only, or as having no relevant modifier. Apparently there are carrier conventions for billing or coding which allocate all payments to one or the other category. The number of cases in which there are appreciable numbers of hospital services billed both ways is never more than a quarter of all carriers for any test and specialty, and is usually less. Moreover, of all the "dual billing" cases, most mean charges are within 10 percent of each other regardless of the form of billing.

There are a few cases in which there is an appreciable difference in mean charges between the two forms of hospital billing and a substantial volume paid in both payment modes. These cases tend to occur in the higher priced tests, and to occur across tests in the same small set of carriers.

Even in these cases, the variation in mean charges by type of billing is not enormous. For example, for CAT scan of the head, the mean hospital charges billed globally vs. those billed for professional services only were

Table 4

COMPARISON OF HOSPITAL MEAN CHARGES:
PROFESSIONAL SERVICES ONLY VS. NO RELEVANT MODIFIER

| TEST | SPECIALTY | NUMBER OF CARRIERS WITH RELEVANT COMPARISONS* | NUMBER OF CARRIERS WITH DIFFERENCE IN MEAN CHARGES > 10% | CARRIER NOS |
|---|---|---|---|---|
| Chest X-ray (1) | Radiology | 13 | 0 | |
| | Clinic, Group Practice | 14 | 1 | 2050 |
| Chest X-ray (2) | Internal Medicine | 0 | 0 | |
| | Radiology | 15 | 0 | |
| | Clinic, Group Practice | 2 | 1 | 951 |
| Routine EKG (Global) | Cardiovascular Disease | 2 | 1 | 865 |
| | Internal Medicine | 0 | 0 | |
| | Clinic, Group Practice | 0 | 0 | |
| Routine EKG (Interpretation Only) | Cardiovascular Disease | 11 | 3 | 580, 865, 2050 |
| | Internal Medicine | 9 | 3 | 951, 1030, 2050 |
| | Clinic, Group Practice | 3 | 2 | 865, 2050 |
| Holter Monitor | Cardiovascular Disease | 2 | 1 | 13310 |
| | Internal Medicine | 3 | 3 | 820, 2050, 13310 |
| | Clinic, Group Practice | 2 | 1 | 2050 |
| Real Time EKG | General Practice | 0 | 0 | |
| | Internal Medicine | 0 | 0 | |
| | Clinic, Group Practice | 0 | 0 | |
| Spirometry | Internal Medicine | 8 | 4 | 580, 621, 951, 2050 |
| | Pulmonary Disease | 7 | 3 | 630, 900, 1370 |
| | Clinic, Group Practice | 0 | 0 | |
| Peripheral Vascular | General Surgery | 1 | 1 | 900 |
| | Cardiovascular Disease | 3 | 1 | 1380 |
| | Clinic, Group Practice | 2 | 2 | 865, 2050 |
| X-ray Pelvis | Orthopedic Surgery | 0 | 0 | |
| | Radiology | 10 | 2 | 951, 1380 |
| | Clinic, Group Practice | 1 | 0 | |
| X-ray Shoulder | Orthopedic Surgery | 0 | 0 | |
| | Radiology | 10 | 1 | 801 |
| | Clinic, Group Practice | 1 | 0 | |
| X-ray Hip | Orthopedic Surgery | 0 | 0 | |
| | Radiology | 7 | 1 | 10071 |
| | Clinic, Group Practice | 1 | 0 | |
| X-ray Knee | Orthopedic Surgery | 0 | 0 | |
| | Radiology | 12 | 1 | 590 |
| | Clinic, Group Practice | 2 | 1 | 2050 |
| X-ray Foot | Radiology | 9 | 1 | 801 |
| | Podiatry - Surgical Chiropody | 0 | 0 | |
| | Clinic, Group Practice | 1 | 0 | |
| Ophthalmic Biometry | Ophthalmology | 0 | 0 | |
| | Clinic, Group Practice | 0 | 0 | |
| Cat Scan of Head | Radiology | 13 | 4 | 580, 590, 910, 930 |
| | Clinic, Group Practice | 0 | 0 | |
| Echography | Radiology | 11 | 3 | 590, 910,930 |
| | Clinic, Group Practice | 0 | 0 | |
| X-ray GI | Radiology | 9 | 0 | |
| | Clinic, Group Practice | 0 | 0 | |

* A relevant comparison is one in which the frequency is greater than 500 for both codes and the lower frequency code is more than 10 percent of the higher frequency.

$83 vs. $94 for carrier 580, $152 vs. $104 for carrier 590, $87 vs. $74 for carrier 910, and $88 vs. $76 for carrier 930. This example also shows that the mean charge is not always higher for the global fee than for the professional fee.

It appears therefore that in the great majority of cases payment for hospital tests is made correctly. There are isolated instances in which the mean charge does differ depending on whether the service is coded as professional only or not. It is, of course, possible that these differences could be due to differences in prevailing charge maxima within carrier regions. But, in the few cases in which they occur, they may well represent mistaken payment practices by each carrier. The problem is not that mean charges paid by a given carrier will vary with the coding, but rather that mean charges for hospital services, and the differential based on them, vary substantially across carriers.

4. Variation Across Pricing Locality Within Carriers

A measure of charge variation likely to have a greater effect on physician location is the variation across pricing locality within a carrier region. Variation here can imply that doctors located near to each other can be receiving different payment. Because specialty-, test-, and location-specific frequencies are quite low for many comparisons, we have not imposed a lower bound on frequencies.

Tables 2-4 in Appendix A display results for two price measures: the global (no modifier) office fee less the "global" hospital fee, and the office fee less the professional services fee for hospital services.

We calculated a standard deviation and coefficient of variation (CV) for the deviation of the pricing locality mean from the mean for the carrier in which it is located. We then weighted each carrier's coefficient of variation by its relative volume to get a national weighted average coefficient of variation within carrier regions. Tables 2-4 indicate that, for most tests, the coefficient of variation in office global fees is modest within carrier regions. The coefficient is typically between five and fifteen percent. For chest, GI, and orthopedic x-rays, and EKG's the coefficient is usually below ten percent. It is also low for ophthalmic biometry. At the other extreme, the coefficient for peripheral vascular testing is about 15 percent for most specialties, and as high as 21 percent for clinics.

The coefficient of variation for hospital fees is slightly higher than that for office fees, but is still moderate. Here also high CVs also characterize peripheral vascular testing and Holter and real time monitoring.

Finally, the tables show a CV for the differential related to the technical component. In this case, though less than across regions, this figure is still relatively large; the variation in the two components is magnified when the differential is calculated. There is substantial variation across pricing localities within a carrier region in the amount of additional revenue a doctor would collect by providing tests in the office, compared to doing them at the hospital.

## CONCLUSION

When observations are aggregated to a national level, there is considerable similarity of mean charges across specialties. But within and across geographic areas, the additional Medicare payments a physician could expect to

earn by providing tests in the office rather than furnishing professional interpretation only is quite variable. If anything, there appears to be more variation across carriers and HCFA regions than within carrier areas. These variations in diagnostic test charges could, of course, be offset by lower fee levels for other services the doctor supplies in connection with a test. At a minimum, however, the marginal net profit from the test as such appears to vary appreciably over space.

## CHAPTER 3: IPA SURVEY AND COMPARISON WITH MEDICARE ALLOWED CHARGES

One approach to judging the appropriateness of Medicare prices is to compare their prices to those being paid by aggressive or efficient private sector purchasers of diagnostic test services. In this chapter we report the results of a survey of large IPA-model HMOs which collected information on their current payment levels for global fees and the technical component for each of the 16 tests. We then compare these private sector payment levels with an estimate of current Medicare payment levels. These levels are based on the BMAD data reported in the previous section, updated to December 1988.

### METHODS AND PROCEDURE

Sixteen of the 30 IPAs we contacted responded to requests for data on the 17 HCPCS codes being studied (Tables 3-1 and 3-2 in Appendix A.1). One code, (abdominal echography, 76705) was not separated out for individual analysis in other sections of this paper. Many IPAs did not provide information on all 17 codes. All IPAs, which were located across the country, had at least 50,000 members. Although large, no IPA had substantial share in any market; its ability, therefore, to exert pressure on prices may be less than Medicare's potential leverage. Three IPAs provided professional and global fee schedules, one provided professional and technical schedules, and 9 provided global schedules only. When professional and global fees were provided, the former was subtracted from the latter to obtain a derived technical fee (see Table 5 which appends this chapter).

In an attempt to ascertain whether there were significant differences among the IPAs an analysis of variance was done. If there were a difference

among IPAs (and there was an IPA effect), the missing cells could be estimated by developing an index. Two analyses of variance were done, one for technical fees, and one for global fees. In doing the analyses HCPCS codes with missing fees were eliminated. In the analysis of technical fees, 10 codes remained (CT scan, both chest X-rays, 4 orthopedic X-rays, upper G.I., ophthalmic biometry, and abdominal echography). The analysis found no IPA effect common to all technologies. Missing values could, therefore, not be estimated.

The second analysis of variance was done on the IPA global fees. In addition to deleting HCPCS codes with empty cells, an additional IPA (IPA #6) was eliminated from the calculations because of missing data. This resulted in 9 HCPCS codes (CT scan, both chest X-rays, 3 orthopedic X-rays, upper G.I., abdominal echography, and one EKG) across 11 IPAs. This analysis also found no IPA effect. Due to these findings, estimations of the missing cells could not be made.

RESULTS

The derived technical IPA fees were averaged, as were the IPA Global fees, and the coefficients of variation calculated (see Table 6 at the end of the chapter). The coefficients of variation of the IPA average global fees ranged from 16.95% to 45.93% depending on the test, with most being between 21% to 33%. The coefficients of variation for the derived IPA technical component ranged from 25.39% to 45.34%. The standard deviations as a proportion of the mean are somewhat larger for the derived technical fees, but this may also be in part due to the small number of cases.

The BMAD data which was utilized for comparison purposes was from 1986, while the IPA survey was based on 1988 fees. The BMAD data was therefore

indexed by using the rate of growth in the Medicare Economic Index for 1987 and 1988, which totals 6.9%. Allowed charges for radiology were updated only by 4.3% due to changes in regulations. Allowed charges for ophthalmic biometry were restricted to 5% of the average allowed charge for the 66984 procedure (cataract removal). The BMAD data was also indexed in an alternative way by using the CPI index for medical care for both years (which totals 15.74%). (This latter procedure is equivalent to deflating the 1988 IPA fees by the CPI, to get back to numbers comparable to the BMAD figures). The results can be seen in Table 7 at the end of the chapter.

The IPA global average fees were compared to the indexed BMAD global fees (Table 8 at the end of the chapter). When compared to the MEI indexed global fees, the IPA fees are higher in all but two cases, both being EKGs. When compared to the CPI indexed BMAD global fees, BMAD fees are higher in all EKG codes, as well as double view chest X-rays radiologic examinations, shoulder, and radiologic examination, foot. The data on the EKGs remains unclear since Q codes which were implemented in 1987 are not reflected in this analysis data (see Chapter 6 for a more extensive analysis of EKG and Holter tests). In 9 of the 14 codes (not including EKGs) the IPA fees are higher than BMAD CPI updated fees.

The IPA derived technical fees are compared to the MEI indexed BMAD technical differentials in Table 9 at the end of the chapter. The table does reveal that there is only one procedure where BMAD fees are higher than the IPA fees: bilateral chest X-rays. In 10 of the 11 codes where complete information is available, IPA fees are higher than BMAD fees.

CONCLUSION

The data indicate that in most cases HCFA is not paying more than aggressive buyers in the private sector for most of its tests. It may be paying a slight fraction more for EKGs as a global fee.

Table 5
IPA DERIVED FEES, BY HCPCS CODES

| TESTS | IPA #1 derived technical fees | IPA #3 derived technical fees | IPA #4 derived technical fees | IPA #5 derived technical fees | Survey's average technical fees |
|---|---|---|---|---|---|
| CT SCAN | | | | | |
| 70470 | $150.00 | $319.52 | $273.00 | $302.38 | $261.23 |
| X-RAYS | | | | | |
| 71010 | $ 13.00 | $ 30.48 | $ 14.00 | $ 21.52 | $ 19.75 |
| 71020 | $ 17.00 | $ 36.48 | $ 22.00 | $ 13.48 | $ 22.24 |
| 72170 | $ 18.00 | $ 36.88 | | $ 31.70 | $ 28.88 |
| 73020 | $ 15.00 | $ 34.32 | $ 19.00 | $ 21.52 | $ 22.46 |
| 73510 | $ 20.00 | $ 45.92 | $ 24.00 | $ 46.40 | $ 34.08 |
| 73560 | $ 14.00 | $ 32.80 | $ 19.00 | $ 31.65 | $ 24.36 |
| 73620 | $ 14.00 | $ 32.80 | $ 16.00 | $ 32.94 | $ 23.94 |
| UPPER GI | | | | | |
| 74240 | $ 36.00 | $ 81.84 | $ 53.00 | $104.62 | $ 68.87 |
| OPHTH | | | | | |
| 76516 | $ 72.00 | $ 65.38 | $ 72.00 | $ 29.38 | $ 59.69 |
| ABD ECHO | | | | | |
| 76700 | $ 50.00 | $138.56 | $ 69.00 | $ 83.71 | $ 85.32 |
| 76705 | $ 33.00 | $ 76.32 | $ 43.00 | | $ 50.77 |
| EKG/HOLT/ REAL TIME | | | | | |
| 93000 | | $ 34.64 | | | |
| 93262 | | | | | |
| 93266 | | | | | |
| PER VAS | | | | | |
| 93910 | | | | | |
| SPIRO | | | | | |
| 94010 | | | | | |

Note: See Table 7 for list of HCPCS codes included in each procedure.

Table 6
IPA AVERAGE FEES SCHEDULES AND COEFFICIENT OF VARIATION BY HCPCS CODES

| TESTS | IPA average global fee of variation | IPA global fees coefficient fee | IPA average derived technical | IPA derived technical fees coefficient of variation |
|---|---|---|---|---|
| CT SCAN | | | | |
| 70470 | $376.96 | 23.77% | $261.23 | 25.93% |
| X-RAYS | | | | |
| 71010 | $ 32.80 | 31.08% | $ 19.75 | 35.52% |
| 71020 | $ 40.58 | 21.92% | $ 22.24 | 39.39% |
| 72170 | $ 40.24 | 28.74% | $ 28.86 | 27.60% |
| 73020 | $ 37.38 | 21.80% | $ 22.46 | 32.20% |
| 73510 | $ 47.39 | 33.29% | $ 34.08 | 35.65% |
| 73560 | $ 38.40 | 22.52% | $ 24.36 | 33.12% |
| 73620 | $ 33.89 | 26.69% | $ 23.94 | 37.44% |
| UPPER GI | | | | |
| 74240 | $116.26 | 34.25% | $ 68.87 | 38.27% |
| OPHTH | | | | |
| 76518 | $156.33 | 32.14% | $ 59.69 | 29.60% |
| ABD ECHO | | | | |
| 76700 | $154.19 | 24.44% | $ 85.32 | 43.80% |
| 76705 | $ 99.95 | 21.85% | $ 43.95 | 45.34% |
| EKG/HOLT/ REAL TIME | | | | |
| 93000 | $ 38.56 | 16.95% | | |
| 93262 | $183.77 | 25.88% | | |
| 93266 | $162.25 | 33.60% | | |
| PER VAS | | | | |
| 93910 | $158.49 | 31.28% | | |
| SPIRO | | | | |
| 94010 | $48.72 | 45.93% | | |

Note: See Table 7 for list of HCPCS codes included in each procedure.

Table 7
UPDATED BMAD FEE SCHEDULES, BY HCPCS CODES

| TESTS | 1986 BMAD average global fee | MEI 1988 updated BMAD average global fee (1) | CPI 1988 updated BMAD average global fee (2) | 1986 BMAD average technical differentials | MEI 1988 updated BMAD average technical differentials | CPI 1988 updated BMAD average technical differentials |
|---|---|---|---|---|---|---|
| CT SCAN | | | | | | |
| 70450, 70460, 70470 | $289.30 | $309.26 | $334.84 | $196.67 | $210.24 | $227.65 |
| X RAYS | | | | | | |
| 71010, 71015 | $ 25.57 | $ 26.66 | $ 29.59 | $ 14.56 | $ 15.19 | $ 16.85 |
| 71020, 71021, 71022, | | | | | | |
| 71030, 71034, 71035 | $ 35.64 | $ 36.81 | $ 41.25 | $ 21.69 | $ 22.62 | $ 25.11 |
| 72170, 72180, 72190 | $ 31.53 | $ 32.89 | $ 36.49 | $ 18.48 | $ 19.27 | $ 21.39 |
| 73020, 73030 | | | | | | |
| 73500, 73510, 73520 | $ 37.46 | $ 39.07 | $ 43.36 | $ 21.88 | $ 22.82 | $ 25.33 |
| 73560, 73562, 73564 | $ 32.06 | $ 33.44 | $ 37.11 | $ 18.96 | $ 19.78 | $ 21.95 |
| 73620, 73630 | | | | | | |
| UPPER GI | | | | | | |
| 74240, 74241, 74245 | $ 87.45 | $ 93.48 | $101.21 | $ 53.74 | $ 57.45 | $ 62.20 |
| OPHTH | | | | | | |
| 76518 | $132.83 | $118.00 | $153.74 | $ 85.24 | $ 45.75 | $ 75.52 |
| ABD ECHO | | | | | | |
| 76700, 76705 | $120.68 | $ 129.01 | $139.68 | $ 72.06 | $ 77.03 | $ 83.41 |
| EKG/HOLT/ | | | | | | |
| REAL TIME(3) | | | | | | |
| 93000 | $ 31.96 | $ 34.19 | $ 37.01 | $ 20.96 | $ 22.41 | $ 24.26 |
| 93262 | $202.05 | $215.99 | $233.85 | $149.82 | $160.16 | $173.42 |
| 93266 | $162.70 | $173.93 | $188.31 | $111.37 | $119.05 | $128.91 |
| PER VAS | | | | | | |
| 93850, 93860, 93890, | | | | | | |
| 93910, 93950, 93960 | $103.27 | $110.40 | $119.52 | $ 64.43 | $ 68.88 | $ 74.58 |
| SPIRO | | | | | | |
| 94010, 94060, 94070 | $ 42.12 | $ 45.03 | $ 48.75 | $ 22.58 | $ 24.14 | $ 26.14 |

Note: (1) The BMAD file was indexed using a weighted average of the MEI components, except for the X-rays and the ophthalmic biometry test, for which we applied the new HCFA regulations.
(2) The BMAD file was indexed using the medical component of CPI
(3) The BMAD fees for EKG/HOLTER/ REAL TIME in Tables 3-5, 3-6, and 3-7, are average allowed charges, while in tables E-2, 5-2 and in the analysis in Chapter 6 we used average prevailing fees.

Table 8
IPA AND MEDICARE AVERAGE GLOBAL FEES, BY HCPCS CODES UPDATED

| CPT-4 Code | IPA average global fees November, 1988 | MEI 1988 updated BMAD average global fees | % difference from MEI updated BMAD average global fees | CPI 1988 updated BMAD average global fees | % difference from CPI updated BMAD average global fees |
|---|---|---|---|---|---|
| CT SCAN | | | | | |
| 70470 | $376.96 | $309.26 | 21.89% | $334.84 | 12.58% |
| X-RAYS | | | | | |
| 71010 | $ 32.80 | $ 26.66 | 23.03% | $ 29.59 | 10.84% |
| 71020 | $ 40.56 | $ 36.61 | 10.84% | $ 41.25 | -1.61% |
| 72170 | $ 40.24 | $ 32.89 | 22.34% | $ 36.49 | 10.27% |
| 73020 | $ 37.38 | $ 34.32 | 8.9 % | $ 38.12 | -1.94% |
| 73510 | $ 47.39 | $ 39.07 | 21.30% | $ 43.36 | 9.29% |
| 73560 | $ 36.40 | $ 33.44 | 8.98% | $ 37.11 | -1.90% |
| 73610 | $ 33.89 | $ 30.84 | 9.89% | $ 34.28 | -1.08% |
| UPPER GI | | | | | |
| 74240 | $116.26 | $ 93.48 | 24.36% | $101.21 | 14.86% |
| OPHTH | | | | | |
| 76518 | $156.33 | $118.00 | 32.48 | $153.74 | 1.69% |
| ABD ECHO | | | | | |
| 76700 | $154.19 | $129.01 | 19.52% | $138.68 | 10.39% |
| 76705 | $ 99.95 | | | | |
| EKG/HOLT/ REAL TIME(3) | | | | | |
| 93000 | $ 38.56 | $ 34.19 | 12.79% | $ 37.01 | 4.17% |
| 93262 | $183.77 | $215.99 | -14.92% | $233.86 | -21.41% |
| 93266 | $162.25 | $173.93 | -6.71% | $188.31 | -13.84% |
| PER VAS | | | | | |
| 93910 | $158.49 | $110.40 | 43.57% | $119.52 | 32.60% |
| SPIRO | | | | | |
| 94010 | $ 48.72 | $ 45.03 | 8.19% | $ 48.75 | -0.06% |

Note: See Table 7 for list of HCPCS codes included in each procedure.

Table 9
IPA AND MEDICARE AVERAGE TECHNICAL FEES, BY HCPCS CODES

| CPT-4 Codes | IPA average technical fees differential | MEI 1988 updated BMAD average technical differential | % difference from MEI updated BMAD technical differential | CPI 1988 updated BMAD average technical differential | % difference from CPI indexed BMAD average technical |
|---|---|---|---|---|---|
| CT SCAN | | | | | |
| 70470 | 261.23 | $210.24 | 24.25% | $227.65 | 14.75% |
| X-RAYS | | | | | |
| 71010 | 19.75 | $ 15.19 | 30.00% | $ 16.85 | 17.19% |
| 71020 | 22.24 | $ 22.62 | -1.68% | $ 25.11 | -11.42% |
| 72170 | 28.86 | $ 19.27 | 49.77% | $ 21.39 | 34.92% |
| 73020 | 22.46 | $ 20.51 | 9.51% | $ 22.77 | -1.36% |
| 73510 | 34.08 | $ 22.82 | 49.34% | $ 25.33 | 34.56% |
| 73560 | 24.36 | $ 19.76 | 23.15% | $ 21.95 | 11.01% |
| 73620 | 23.94 | $ 17.85 | 34.12% | $ 19.81 | 20.85% |
| UPPER GI | | | | | |
| 74240 | 68.87 | $ 57.45 | 19.87% | $ 62.20 | 10.71% |
| OPHTH | | | | | |
| 76516 | 59.69 | $ 45.75 | 30.47% | $ 75.52 | -20.96% |
| ABD ECHO | | | | | |
| 76700 | 85.32 | $ 77.03 | 10.76% | $ 83.41 | 2.29% |
| 76705 | 36.08 | | | | |
| EKG/HOLT/ REAL TIME | | | | | |
| 93000 | | $ 22.41 | | $ 24.26 | |
| 93262 | | $160.16 | | $173.42 | |
| 93266 | | $119.05 | | $128.91 | |
| PER VAS | | | | | |
| 93910 | | $ 68.88 | | $ 74.58 | |
| SPIRO | | | | | |
| 94010 | | $ 24.14 | | $ 26.14 | |

Note: See Table 7 for list of HCPCS codes included in each procedure.

## CHAPTER 4: PRICING BASED ON RETURNS TO CAPITAL INVESTMENT

### CONCEPTUAL ISSUES IN APPLYING A RETURN-ON-INVESTMENT MODEL TO DIAGNOSTIC TEST PAYMENT

Medicare seeks to pay the lowest price for the services it receives, conditional on attainment of adequate quality and access for beneficiaries. This objective, in turn, implies that price should be high enough to cover the cost of "appropriate" providers. If all providers are thought to be of equal potential efficiency and if there are no economies of scale, there is a simple pricing rule: set price just high enough to cover all costs of efficient production, including the real cost of capital. Especially for services for which capital is an important input, a statement which is conceptually equivalent is the following: set price so that the income net of all other costs just equals the competitive price or required return for capital investment.*** That is, the price should yield a return on capital equal to the market return available to investors from investing that capital in alternative ways.

Such a "return on investment" (ROI) approach has traditionally been used to help set prices for natural monopolies regulated as public utilities. In the case of a single (regulated monopoly) firm, the rule is simple: the firm should earn an average return equal to the competitive rate. When multiple firms are in the industry, the return has to be sufficient to yield the going rate to the marginal firm (last one desired to be in the industry) and the

***At this level, there is no particular reason to choose capital as the input. One could as well have set price to yield a return to suppliers of materials which, after all other costs are deducted, equals the competitive price of materials.

marginal investment (last dollar of capital desired to be invested by any firm).

Although there are some biases introduced by this method in the public utility case--primarily the "Averch-Johnson" effect involving excessive capital investment--it can be implemented effectively for single public utility firms such as electricity distribution, local telephone service, and the like.[1] However, even in the case of traditional regulated industries, use of this method poses additional problems where there are many firms operating in a single market whose prices are to be regulated. Both airlines and common carrier trucking represented industries with multiple firms subject to public utility regulations, but have now been deregulated. The reason for deregulation is subject to some controversy. The most important reason for deregulation is that firms in this industry had ceased to be natural monopolies, if they ever were, so that a conventional competitive market was thought to be feasible. Deregulation was a way to achieve that market.

At least for the present, a conventional competitive market does not appear to be feasible for physician-provided diagnostic tests for Medicare beneficiaries, because of virtually complete insurance coverage, public and private. Some method of price administration is thought by most to be required. However, some of the other problems which have had to be addressed by public utility regulation with multiple firms will also arise in an attempt to extend this approach to diagnostic testing. They will, therefore, also have to be addressed by HCFA.

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[1]H. Averch and L. Johnson, "Behavior of Firm Under Regulatory Constraint," American Economic Review 52 (December, 1962), pp. 1052-69.

In the multiple firm case, special complexities arise. For instance, cost variations across firms must be considered in developing a method for appropriate pricing. There are three major sources of cost variation. One source of variation across geographic areas comes from variation in the prices paid for non-physician inputs into diagnostic tests, such as non-physician personnel, supplies, utilities, and rent. If it were administratively feasible to calculate separate prices for different areas and monitor the return in each area in which input prices differed, the problem would be solved automatically. Especially if, as seems reasonable, the cost of capital is assumed to be uniform nationwide, one need then only set the output price which yields that return on investment in each area. Calculating the rate of return automatically takes into account variation in all input prices except the price of capital. If, for example, wage rates are higher in one market than another, and everything else is the same, then a higher output price will be required in the high wage area to yield the same rate of return on capital. Of course, if physicians would be willing to work for less in high-wage areas (because, perhaps, of the cultural attractions of big cities), then a lower subjective cost of physician time might offset a higher cost of non-physician time.

The main question is that of the administrative feasibility of making separate calculations (and of defining market areas), since some averaging will always have to be done. We will explicitly show how input price variation affects our sample calculations of rate of return-based pricing.

The second source of cost variation is variation across firms in managerial skill or effort--what we usually call "efficiency." It may well be that not all firms or physicians can be equally efficient, try as they might. Past

decisions and the unequal distribution of managerial genius may lead to different levels of outputs achievable with similar sets of inputs, and wages for managers may not fully offset superior managerial skill. This conjecture is probably more true for physicians who are not selected for the managerial role because of an aptitude for management, than for other industries in which the manager need not be a licensed professional. Efficiency remains a controversy even in public utility pricing, with regulators frequently alleging the firms are not producing efficiently, and proposing to base prices on the level that would yield a market rate of return if production were efficient (rather than being based on costs actually incurred at present). Efficiency will probably be an even greater source of controversy in medical settings.

The same issue will obviously arise in pricing physicians' services, given the wide variation in physician productivity which we know exists (though we do not know how much variation there is for diagnostic tests in particular). There is an unavoidable dilemma here, however. On the one hand, we do not want to pay inefficient firms, or physicians, a price that covers the cost of the inefficiency, holding quality constant. On the other hand, there will surely be some physicians who either cannot or will not become efficient. Setting a price which fails to cover their "high" cost will then cause them to reject Medicare patients, or to refuse assignment or participation. There is, therefore, an inevitable tradeoff between the price Medicare pays and the access it buys. There is no such thing as the cost which it should cover; instead, physicians who differ in managerial skill will represent a range of costs in a market area--even when all physicians minimize costs as well as they can. The choice for Medicare then is which cost it

wants to pay--which is equivalent to choosing which physicians it wants to render services to Medicare patients. There will, therefore, always be some producer on the margin. The critical empirical question is how steep or elastic that margin is--does a reduction in price lose just a little access, and just a few physicians, or does it lose many?

The third source of cost variation faced by public utility-type regulation arises from a likely divergence between marginal and average cost. For the physician who buys a piece of diagnostic test equipment--just as for the electric utility that builds a new generation plant--the cost of additional output (marginal cost) is likely to be less than average cost up to the limit of capacity. A rate of return-based pricing arrangement implicitly sets price equal to average cost, even though pricing at marginal cost would convey better signals to consumers. Inappropriate consumer pricing is unlikely to be a problem for Medicare, given the presence of insurance coverage which insulates the demander from the price. If anything, because of insurance, the user price for Medicare beneficiaries is likely to be below marginal cost.

There is, however, another problem which Medicare will have that the more typical public utility regulator can avoid. When marginal cost is below average cost, this means that average cost will decline with output. Hence, for a somewhat different reason, there is no such thing as <u>the</u> cost. A traditional single public utility is required to serve all demanders in its market, so the regulator need only set the price at average cost at the level of volume at which all demanders are satisfied. Moreover, one would not usually assume that a regulated electrical utility would have the power to create or generate demand. Physicians may be able to generate demand, so that

a price equal to average cost but above marginal cost will convey distorted signals to physicians. In addition, for multiple firm markets such as physicians providing diagnostic tests, there is no simple rule HCFA can adopt to pick the right output for each firm, and, therefore, no obvious basis for designating the right cost to which price should be equated.

It follows that in order to specify the "appropriate" price for physician-provided tests one must first decide which physicians should furnish such tests and what their volumes should be. Put slightly differently, any price will be a "normal return" price for some doctors, at some volume. Other physicians who are more efficient producers or who have higher volumes demanded from them will then earn above-normal returns. The higher the price, the more doctors will find that investing in equipment yields them enough return to cover their borrowing cost and/or the return they could have earned in other investments, and the smaller will be the average volume per provider. In this sense there is a tradeoff between the price and the number of doctors providing tests in their offices. In this limited sense, there is a tradeoff between price and access to office testing. However, it is by no means obvious that greater access of this type is necessarily desirable, given the possibility of low accuracy or quality with low volume, nor is there necessarily a serious problem of inconvenience or time cost to beneficiaries from the absence of access to physician-providing testing in all physician offices. But there could be a problem. The extent to which "access" is a potential problem will vary with the type of test. Failure to have EKG equipment, at least of a basic type, in any primary-care physician office is likely to represent low quality, but it would hardly be necessary to have a similarly widespread distribution of ultrasound capability.

Whatever level of "access" HCFA wants to buy, it still remains true that the appropriate price depends on the level of volume desired; if prices are to be constant, the pricing question simply cannot be answered without a prior answer to the desired volume question. It is also almost always true that, at any price, some doctors will earn more than normal profit, but none will earn less than a normal return in equilibrium. Consequently, the average return actually earned by doctors who choose to invest in machines must stay perpetually above the normal rate. For both of these reasons, estimates of current rates of return do not unequivocally indicate whether price is too high. The smaller the degree of variation in managerial skill or volume, the smaller this "infra-marginal" profit will be. What we can do, however, and what will be presented in this report, is to illustrate the set of prices that are "normal return" prices for alternative levels of test volume.

## OBJECTIVES OF THIS TASK

A major effort of this project was to explore the development of estimating reasonable or appropriate prices for the technical component diagnostic tests by using a return on investment approach. This chapter and the next summarize the results of that analysis.

In this chapter, we discuss the conceptual framework for the net present value (NPV) approach that followed.

We then describe the process followed to apply this method to information obtained from manufacturers' representatives and other sources. We illustrate how the framework is applied to such data by using an example of one test, that of spirometry.

Chapter 5 summarizes the results of two types of analysis.

1. Given assumptions about volumes, "breakeven" or normal-return prices for 1988 are calculated.
2. Given the 1986 BMAD prices updated to 1988, "breakeven" or normal-return volumes are calculated. The prices used for most of the tests are the technical component prices derived from the BMAD analysis of chapter 2. For the ambulatory cardiac monitoring procedures (those with "Q" codes), the BMAD data does not provide sufficient detail. For these procedures, the Medicare mean prevailing charge (not approved charge) was calculated from other data sources.

After providing a summary of results for the sixteen tests, we then give more detail on our choice of assumptions for each test in a test-by-test narrative. We report on fourteen tests in this chapter. More detail on Holter and real time EKG monitoring is provided in Chapter 6.

## NET PRESENT VALUE METHODOLOGY: CONCEPTUAL FRAMEWORK

The rate-of-return analysis is intended to define the price (given volume) or the volume (given price) necessary to provide a reasonable rate of return to the physician investing in diagnostic equipment. *A reasonable rate of return* is defined as a return to the physician equal to the opportunity cost of the capital funds he or she has invested in the technology.

The theoretical framework used in the rate of return analysis is the discounted cash flow net present value (NPV) approach. This approach will allow us to determine the price or volume at which the physician will earn a reasonable rate of return. The NPV approach is the soundest methodology theoretically, and a version of it has been used in other studies determining

appropriate rates of return for health care providers.[2] It is important to distinguish the economic rate-of-return defined here from the traditional accounting measure, return-on-investment (ROI). ROI requires the use of accounting book values, not market values, for its determination, and is therefore less meaningful economically.

The essence of the NPV approach is that all cash flow consequences of a capital investment are determined, all future dollars are discounted to present dollars, and the value of the investment in today's dollar is netted against the initial capital expenditure. Any investment whose NPV is zero or larger provides at least a reasonable rate of return to the supplier or capital.

The Investment Decision[3]

In the following, the basic approach for investment decisions is broken into steps and discussed in more detail, after which the application to physician investment is discussed.

1. First forecast the incremental cash flows generated by the investment over its life. The rule is simple but sometimes more complicated to implement: only cash flow increments (positive or negative) should be considered. This means that we must make adjustments to traditional

[2]For a discussion of this approach as applied to nursing homes see CY Baldwin and CE Bishop, "Return to nursing home investment: Issues for public policy," Health Care Financing Review, Summer 1984, 5(4).

[3]This discussion follows that in RA Brealey and SC Myers, Principles of Corporate Finance, McGraw-Hill New York, 1981; and in TE Copeland and JF Weston, Financial Theory and Corporate Policy, 3rd ed., New York: Addison-Wesley, 1988.

accrual-based accounting measures, ignore sunk costs, and recognize opportunity costs.

2. Determine the opportunity cost of capital. The opportunity cost of capital for an investment must reflect two things:
   - o The time value of money. "A dollar today is worth more than a dollar tomorrow".
   - o The risk of the investment. "A safe dollar is worth more than a risky one". Risk relates to variability in return. Risk must be compensated for by higher expected return.

   The cost of capital then is constructed in two pieces:

   r = risk-free rate reflecting time preference and anticipated inflation

   +

   premium for the riskiness of the project

   Determining a precise opportunity cost of capital is difficult. The first component, the time value of money, can be determined readily by looking at the going rate for essentially riskless securities such as Treasury Bills. There is a huge literature on defining the second component, the relative risk of investments, almost all of which deals with the risk of publicly traded companies. Essentially we can think of an average risk premium for the average risk investment, which is adjusted up or down based on the risk of the investment as compared to the average. Exactly how this should be applied to a doctor's decision to invest in office equipment is not known.

3. Discount the future cash flows using the opportunity cost of capital. Summing these gives the present value of the cash flows. This can be represented with a simple formula:

$$PV = \sum_{t=1}^{T} \frac{NCF_t}{(1+r)^t}$$

where t is an index for time, T is the number of periods of economic life of the investment, $NCF_t$ is the net cash flow for the period, and r is the opportunity cost of capital.

4. Subtract the initial capital investment from these cash flows to give the Net Present Value (NPV). This can be represented in the formula by changing the initial setting of the time index to t=0:

$$NPV = \sum_{t=0}^{T} \frac{NCF_t}{(1+r)^t} \qquad (1)$$

Recognizing that net cash flow in each period is equal to revenue minus costs, and that revenue equals price times quantity, we can rewrite net cash flow:

$$NCF_t = P_t \times Q_t - C_t$$

Expression (1) can then be rewritten:

$$NPV = \sum_{t=0}^{T} \frac{(P_t \times Q_t - C_t)}{(1+r)^t} \qquad (2)$$

Note that $C_t$ is a complicated function of $Q_t$, incorporating capital, non-physician labor, supplies, maintenance and overhead.

Two equivalent rules for investment projects can be stated:

1. Accept positive NPV projects
2. Accept projects which return more than their opportunity cost of capital

This simple description of the method becomes more complicated when tax considerations and other factors are included, but the fundamental idea is unaffected.

A comment should be made about the treatment of inflation and interest rates in this analysis. It makes no essential difference how inflation is treated as long as the treatment is consistent. If real cash flows are discounted by the real discount rate, the net present value will be exactly the same as if nominal cash flows were discounted by the nominal discount rate. The real discount rate was calculated as follows:

$$\text{Real discount rate} = \frac{1 + \text{nominal discount rate}}{1 + \text{inflation rate}} - 1$$

The approach we have taken here is to discount real cash flows (that is, in today's prices) by an estimate of the real (inflation-adjusted) discount rate.

Taxes and the Financing Decision

In perfect capital markets, the method of financing an investment, whether borrowing or equity, is irrelevant to the return or to the optimal investment decision; any mix of borrowing and equity is as good as any other. In real world markets, taxes are the major imperfection that need to be addressed in assessing the impact of the financing decision on the investment. Because the tax code allows explicit interest payments on business debt as deductions from income, but does not permit deduction of implicit interest on equity investment, it is less expensive (up to a point) to use debt rather than equity. (At some point the potential costs of financial distress due to excessive debt outweigh the advantage). The cash flow consequences of the debt-tax effect need to be taken into account. This can be done in a simple

fashion by a minor addition to the steps listed above. Using what has been called the Adjusted Present Value approach,[4] we simply calculate the NPV as described above, and compute a separate present value of the interest tax shield. The NPV is then "adjusted" by adding to it the present value of the tax shield. These calculations are done separately because the interest tax shield effects are discounted at the loan interest rate, rather than at the opportunity cost of capital which appropriately reflects the risk of the payments. An alternative method (not used in this analysis) is to adjust the cost of capital for the percentage of debt and equity used.

The interest tax shield is calculated by taking the outstanding loan balance in each period and multiplying it by the loan interest rate and the tax rate, and then discounting back to present dollars. The net present value is just the sum of the present values of each period. We can describe this with a formula. Let:

$K$ = initial capital purchase

$u$ = percentage of total machine use for the procedure being analyzed

$b$ = percentage of capital borrowed

$K \cdot u \cdot b$ = amount borrowed to finance the equipment for this procedure

$I$ = term of loan

$i$ = time index

$r_L$ = loan borrowing rate

$r$ = marginal income tax rate

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[4]SC Myers, "Interactions of Corporate Financing and Investment Decisions -- Implications for Capital Budgeting," Journal of Finance, 1974; 29:1-25.

First we introduce taxes into expression (2):

$$NPV = \sum_{t=0}^{T} \frac{(P_t \times Q_t - C_t)(1 - \tau)}{(1 + r)^t} \tag{3}$$

This reduces the physician's income by a factor of $(1 - \tau)$. However, we have to add back to interest tax shield.

The expression for the interest tax shield is

$$\text{Interest Tax Shield NPV} = \sum_{i=1}^{I} \frac{[K \cdot u \cdot b \frac{(I - i + 1)}{I}] r_L \tau}{(1 + r_L)^i} \tag{4}$$

$K \cdot u \cdot b$ is just the initial loan balance and $[(I - i + 1)/I]$ is a factor which reduces the loan balance by equal amounts in each period. Thus the term in the brackets is the outstanding loan balance in each period i. The interest on this balance is this amount times the loan interest rate $r_L$, and the amount of tax savings is this product times the tax rate $\tau$. This is all discounted back by the discount factor in each period $(1 + r_L)^i$.

Using the adjusted present value approach, expression (4) is added to (3). In (3), we have reduced income by the full tax rate, and then we add back that amount, calculated in (4), which is saved due to the deductibility of interest expense. Note that the actual dollar amount of (4) is usually not large relative to (3).

A similar adjustment must be made to reflect the deductibility of depreciation expense from income. This deduction also has cash flow consequences since it produces tax savings in each period the deduction is taken. We calculate the depreciation tax shield using the straight line depreciation method. The equipment purchase price (reduced by the utilization

First we introduce taxes into expression (2):

$$NPV = \sum_{t=0}^{T} \frac{(P_t \times Q_t - C_t)(1 - \tau)}{(1 + r)^t} \tag{3}$$

This reduces the physician's income by a factor of $(1 - \tau)$. However, we have to add back to interest tax shield.

The expression for the interest tax shield is

$$\text{Interest Tax Shield NPV} = \sum_{i=1}^{I} \frac{[K \cdot u \cdot b \frac{(I - i + 1)}{I}] r_L \tau}{(1 + r_L)^i} \tag{4}$$

K·u·b is just the initial loan balance and $((I - i + 1)/I)$ is a factor which reduces the loan balance by equal amounts in each period. Thus the term in the brackets is the outstanding loan balance in each period i. The interest on this balance is this amount times the loan interest rate $r_L$, and the amount of tax savings is this product times the tax rate $\tau$. This is all discounted back by the discount factor in each period $(1 + r_L)^i$.

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A similar adjustment must be made to reflect the deductibility of depreciation expense from income. This deduction also has cash flow consequences since it produces tax savings in each period the deduction is taken. We calculate the depreciation tax shield using the straight line depreciation method. The equipment purchase price (reduced by the utilization

percentage factors u) is divided by the number of years of (IRS allowed) useful life and multiplied by the tax rate for each period. Then the amount for each period is discounted at the cost of capital r. Let:

D = number of years of depreciation allowed by the IRS (the "IRS allowed useful life")

d = time index

Then the depreciation tax shield is given by:

$$\text{Depreciation Tax Shield NPV} = \sum_{d=1}^{D} \frac{[(K \cdot u)/D]\, \tau}{(1 + r)^d} \tag{5}$$

In the usual case for medical equipment, the IRS allowed useful life D is equal to five, so we get a depreciation tax shield in each period of 1/5 the capital expense times the tax rate. This is discounted back to present value.

The final expression used in our analysis is then just the sum of expressions (3), (5), and (4):

NPV = Before deductions NPV + depreciation tax shield NPV + interest tax shield NPV

$$= \sum_{t=o}^{T} \frac{(P_t \times Q_t - C_t)\,(1 - \tau)}{(1 + r)^t} + \sum_{d=1}^{D} \frac{[(K \cdot u)/D]\, \tau}{(1 + r)^d} + \sum_{i=1}^{I} \frac{[K \cdot u \cdot b \dfrac{(I - i + 1)}{I}] r_L\, \tau}{(1 + r_L)^i} \tag{6}$$

Using the Theory for Physician Investments

The primary difficulty in applying the NPV approach to investments by physicians in diagnostic technology is in determining the appropriate opportunity cost of capital. The cost of capital, or discount rate, for the

physician is somewhat problematic; however, several considerations allow us to arrive at a reasonable estimate. Before exploring these, a comment is in order. Many types of medical equipment have relatively short useful lives and relatively small cash flows in future periods. For these types of technologies the outcome of the analysis is in general not as sensitive to the rate used as for longer lived investments.

Let us first define a lower bound for the cost of capital. If we think of the physician as an entrepreneur, then rational investment in office equipment must return at least as much as could have been earned in an investment of equal risk elsewhere in the economy. Anyone loaning the physician money would not demand as high a return as the physician, as they would have priority in payment in the event of bankruptcy. Therefore, the opportunity cost of the physician's capital must be greater than the loan rate available.

How high above the borrowing rate will the cost of capital be? The cost of capital must incorporate the risk of the use to which the funds are put. Theoretically, all investments can be ranked according to relative risk, although risk adjustment is most widely applied to investment in corporate stocks. The average risk premium for corporate stocks is approximately 8%.[5] The risk premium of a particular investment will be higher or lower than this value depending on whether the investment is more or less risky than the average stock. It would be difficult to actually ascertain precisely the risk of a physician investment in equipment. We expect the risk of buying

[5]RG Ibbotson and RA Sinquefield, Stocks, Bonds, Bills, and Inflation: The Past (1926-1976) and the Future (1977-2000), Charlottesville, VA: Financial Analysts Research Foundation, 1977.

equipment for a fully reimburseable procedure to be fairly low, that is less than average. In order to produce a somewhat conservative (higher) estimate of a required breakeven price, we will assume a 10% real cost-of-capital for the physician, based on a 6.5% risk premium. This is computed as:

1. Nominal discount rate = nominal risk-free rate + risk premium

$$= 9\% + 6.5\% = 15.5\%$$

2. Real discount rate = $\frac{1 + \text{nominal discount rate}}{1 + \text{inflation}} - 1 =$

$$= \frac{1.155}{1.05} - 1 = 10\%$$

A further adjustment should be made for personal income taxes. When the income tax applies to all investments the investor might make, the opportunity cost of capital is reduced by a factor $(1 - k)$, where $k$ is the tax rate. We allow for this additional downward adjustment of the cost of capital in the sensitivity analysis, and maintain the assumption of a 10% cost of capital in the baseline analysis. This approach adds to the conservatism of our estimates.

Using the NPV Calculation to Define Normal-Return Prices and Volumes

In the usual application of the NPV approach to investment decisions, we have (at least estimates of) all the information, including price or volume, and we solve an expression like (6) for the net present value. In this analysis, instead we will set NPV to zero (implicitly returning to the physician his opportunity cost of capital) and solve for one of two variables. When we have information on the average annual volume for a procedure, we solve for the price P which yields the market (opportunity cost) rate of return. In this analysis, we will refer to this price as the normal-return

price although "break-even" price is also used, remembering that it nevertheless includes enough to provide a competitive or market rate of return for the physician. This price can then be compared to the price currently (1988-89) being paid by the Part B program. We can also use the 1986 (mean) price paid by Part B for the technical component of a procedure (as calculated from the BMAD or other data), and then determine the annual volume Q that would have produced a reasonable rate of return at that price, given the assumptions of the analysis. As discussed above, for some procedures the Medicare mean prevailing charge is used. A detailed discussion of how these calculations are made is given in the next section. Note that (6) has not been solved for P or Q explicitly. A computer is used to iterate to a solution when we have values for the other variables.

Application to Diagnostic Technologies

The rate of return analyses use the methodology described above to calculate normal-return prices and volumes for each of the technologies. Below, the sources of data and assumptions are described, and the calculations are explained.

Ideally, much of this data would have been gathered in a larger and costly survey of physician's offices. This would have surveyed, by specialty, the types of personnel used, specific equipment and prices, procedure times, etc. However, it is possible that even if such a survey had been conducted, the response rates and accuracy of the information received would have been less than desirable.

The information about specific technologies used in the analysis for this interim report was instead gathered in phone interviews and written

correspondence with equipment manufacturers, providers, and medical societies. When possible, information was gathered from multiple sources to validate the estimates. Our degree of confidence in the data is better for some items than for others. The general approach in the assumptions and the calculations was to deal with uncertainty by being conservative. That is, the analysis will tend to err in the direction of over-stating the required normal-return price rather than understating it.

Each procedure code is analyzed for four different types of practitioners. "High end" practitioners are defined to be those who have characteristics which cause the break-even price to be at the high end of the reasonable range. "Low end" practitioners have characteristics which cause the break-even price to be in the low end of the reasonable range. Examined are low-end non-specialists, high-end non-specialists, low-end specialists, and high-end specialists. In addition, for the low-end non-specialist and the high-end specialists, sensitivity analyses identify the data and/or assumptions that are most important to the determination of the break-even price. By "specialist" here we mean a specialty for which the particular test is a central part of the diagnostic process for a patient typical of the type that a specialist sees. A "non-specialist" is then a doctor who would not concentrate as much in the type of patient who uses the test. Consequently, in our discussion, a "non-specialist" may have a medical specialty, just not the one for which the test is central. For instance, for orthopedic x-rays, the orthopod will be the specialist, and the internist will be the non-specialist. Non-specialists were chosen based on their having high total volumes of the indicated test.

Spirometry - An Example

The following sections use the example of spirometry for a high-end specialist to illustrate and discuss the assumptions and calculations underlying the work sheets. The discussion refers to the accompanying (see end of chapter) spirometry worksheet. The worksheets for each scenario consist of from 2 to 4 pages. The first page is always the main cash-flow statement. This page has two boxes at the top. The first box identifies the technology evaluated and the specific scenario, e.g., spirometry for a high-end specialist. The second box contains the assumptions and input data necessary to compute the net present value. A second page of the cash flow statement will be included if the useful life is longer than 7 years.

The second (or third) page contains two things. First is the computation of the four operating expenses: Personnel, supplies, maintenance, and overhead. Second is a table which computes the net present value of the interest tax shield.

For the high-end specialists and low-end nonspecialist, a last page will contain a sensitivity analysis. This page shows how the normal-return price changes with a 25% change up or down of key variables such as volume, useful life, and operating expenses. The worksheet and its calculations are described in detail below.

Assumptions Common to All the Analyses

Critical input data and assumptions are summarized at the top of the work sheet. The information contained in the box is all that is necessary to make the calculations in the worksheet. For some pieces of information, the same values are used in all the worksheets. The calculations to arrive at these

numbers are given below. The other information is specific to the technology or to a single scenario. The source of this data and general considerations are discussed further below; more detail is provided where necessary in the discussions of the individual technologies.

PHYSICIAN'S COST OF CAPITAL: The physician's cost of capital was discussed extensively above. To produce a somewhat conservative (higher) estimate of a required break-even price, we calculated a 10% opportunity cost of capital. This figure is used in all the analyses, which assumes that investing in any of the technologies by any type of physician has equal risk. This assumption is not perfectly realistic. However, defining relative risks for the technologies would have to be done on a very subjective basis. This problem is handled by changing the discount rate up and down by 25% in the sensitivity analysis. This provides break-even solutions at various values of the discount rate, and also shows in most cases that the results are fairly insensitive to rates in a reasonable range.

MARGINAL TAX RATES: The marginal income tax rate is determined by taking the personal federal tax rate 28%, which will be the rate for most physicians, and adding to it an average of the top personal state tax rates in the 50 states and the District of Columbia (6.5%).[6] Thus the marginal rate used in the computations is 34.5%. (The corporation income tax is not used because physicians who are proprietors or partners are the subject of the analysis. Extending the model to incorporated practices would require treating the corporate tax rate on reported net earnings, dealing with the double taxation

[6]Computed from the top personal rates given in the State Tax Guide, Commerce Clearing House, Inc., 1988.

of those earnings, and incorporating the corporate tax shield on retained earnings.)

OVERHEAD COSTS PER SQUARE FOOT: The overhead cost per square foot is a simple average of the 1988 retail rental rates for metropolitan areas from the National Real Estate Index.[7] The justifications for using this data are as follows. In calculating the Medicare Economic Index (MEI), using this type of data to determine physician office space rates was passed over for a much more extensive data base maintained by the U.S. Department of Housing and Urban Development for apartment rental rates. However, the apartment rental data was used to determine rates of change for rental rates of physicians' offices, based on the hypothesis that the price per square foot grew at the same rate for both types of space.[8] This is clearly inappropriate to determine levels of rental rates for physician offices.

The National Real Estate Index tracks apartment rental rates, retail space and office space, in ascending order of price. The office space figures tracked are for central city locations and were felt to be too high for physician offices. The office space figures were 2-3 times higher than the retail and apartment rental rates. On the other hand, apartment rental space does not appropriately reflect the type of space most physicians use for office space. Falling in the middle, retail space rates seem to provide a reasonable estimate. The data probably overestimates the average office

[7]Data was taken from the National Real Estate Index, Liquidity Fund, Emeryville, CA, 1988.

[8]Stephen Zuckerman, WP Welch, and Gregory C. Pope, "The Development of an Interim Geographic Medicare Economic Index," HCFA research grants 18-C-98326/1-01 and 17-C-98758/1-03.

rental rate since it comes only from metropolitan areas. This probable overestimate is offset by ignoring overhead costs not directly related to space. For example, incremental electricity or administrative expenses are not included in the expenses for the technologies. The mean price calculated was $13.70 per square foot per year.

LOAN INTEREST RATE: The loan interest rate is used to calculate the repayment structure and the interest tax shield when it is assumed that the physician borrowed funds to finance the purchase of capital equipment. The real rate of 6% was determined by using the current prime rate (10.5% ), adding 1% (giving the usual rate paid by physicians), and adjusting for the recent historical inflation rate (5%):

$$\text{real loan rate: } \frac{1 + .105 + .01}{1.05} = \frac{1.115}{1.05} = 6\%$$

HOURLY PERSONNEL COSTS: Most of the analyses use average hourly wage rates calculated for clerical workers/technicians, L.P.N.'s, and R.N./technologists.[9] The 1987 data was inflated by 4% into 1988 dollars. All wage rates were multiplied by an additional 28% to account for fringe benefits and payroll tax. The standard rates including the 28% adjustment are:

Technician/Clerical: $10.25/hour

L.P.N.: $10.52/hour

R.N./Technologist: $16.04/hour

The type of personnel used to perform most of the procedures can vary. In these cases, the more expensive personnel were assumed to be used in the

[9]Data from Current Population Survey, U.S. Bureau of Labor Statistics, 1987.

high-end or specialist scenarios. The spirometry example uses the L.P.N. personnel hourly rate of $10.52 per hour.

Assumptions and Calculations Specific to Each Technology

The input data used varies by technology. A general description of the approach and the data used for the spirometry example are described here. More detailed information is provided when necessary in the discussions of the individual technologies.

USEFUL LIFE: There are two useful life figures used. The number at the top of the worksheet refers to the number of years the equipment is actually thought to be useful, rather than the number of years used for depreciation on the tax return. This actual number of years of useful life determines the time horizon of the cash flow in the analysis. Useful life figures were gathered from manufacturers and medical societies. Generally, the useful lives are shorter for specialists and high-end users than for non-specialists and low-end users. The second type of useful life figure is the IRS-allowed useful life, which determines the number of years over which there is a tax deduction for the equipment depreciation. Generally the IRS allows 5 years for medical equipment, and this assumption is used throughout for the time horizon of the depreciation tax shield (discussed more fully below). In the particular case of spirometry, the actual useful life of 5 years coincides with the useful life allowed by the IRS for depreciation purposes.

ANNUAL VOLUME: The annual volume is an important variable in determining the appropriate price for a procedure on a rate-of-return basis. For many procedures, especially those requiring large capital investments, the price required for a market return is sensitive to the assumed annual volumes. For

some of the procedures it was difficult to get actual or plausible average or typical annual volume estimates with any degree of precision. Neither manufacturers nor providers were willing or able to provide this information. For most equipment, an upper limit on volume is defined by the natural limits of the procedure itself. For example, if a procedure takes one hour to complete, the equipment's maximum volume will be 8-9 procedures per day. This is a key variable in the calculations, and any follow-up studies should determine volumes through a survey of physician offices or other means. Reasonable estimates were obtained for some procedures for which there was data. Data on weekly number of visits by specialty, and percentage of visits utilizing a diagnostic test by specialty were used to calculate average weekly volumes.[10] The baseline number of annual procedures determined in this way for spirometry for a high-volume specialist is 500.

PERCENTAGE OF CAPITAL PURCHASE DEBT FINANCED: This defines the percentage of the initial capital purchase that was financed using debt. Debt finance has real impact on the cash flow since interest payments on the loan are tax deductible. Data was not available as to the average percentage of equipment purchases that were debt financed. The general approach taken was to assume that relatively less expensive capital equipment was not debt financed. The percentage is varied in the sensitivity analysis, and it generally does not affect the outcome significantly. For the high-end specialist in the example, it is assumed the spirometry equipment is purchased outright.

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[10]Data from Robert C. Mendenhall, Medical Practice in the United States, Robert Wood Johnson Foundation, 1981.

PERCENT UTILIZATION: Percent utilization refers to percentage of actual equipment utilization attributable to this particular procedure. The percentage utilization is based, first of all, on the technology itself. If the technology is only capable of doing one procedure, then the full cost (100% utilization) of the capital expense is attributable to this procedure. If the machine is technologically capable of performing other procedures, then the percentage utilization for a given procedure must be based on average percentage of total usage for the procedure being analyzed. Estimates of the extent to which the machine is used for the particular procedure being analyzed, as a percentage of the machine's total use, was gathered from manufacturers or providers. The degree of confidence in estimates of this percentage for multiple use machines varies, and the importance of the assumption is explored in the sensitivity analysis. Note that the percentage utilization is used in the calculation of equipment purchase price, overhead, and maintenance, but not in the technician and supplies expenses, which are calculated on a per-procedure basis for this procedure only. The spirometry example uses a 30% utilization rate for this procedure, based on the average of estimates of manufacturers. Other more sophisticated procedures can also be performed on the same machine (a specialist has a more expensive, more sophisticate spirometer), and a specialist would be likely to perform many or most of these procedures.

EQUIPMENT PURCHASE PRICE: Equipment purchase prices were gathered for the most part from the manufacturers. Ranges and typical values for generalists and specialists were obtained, along with typical discounts from list prices. Again, this information would ideally have been gathered from the physicians themselves, but the degree of confidence in the data obtained

is fairly high. The high-end specialist and low-end non-specialist scenarios generally use values near the maximum and minimum respectively. The other two scenarios use more typical values. In the example, the high-end specialist is assumed to purchase a relatively expensive spirometer costing $8,000.

MAINTENANCE: The prices of service contracts (as an annual percentage of purchase price) were obtained from the manufacturers, and ranged from 5 to 10% These values were used in the high-end scenarios. No data was available on maintenance costs for those without service contracts. It was assumed that the cost of maintenance for the low-end providers was 1/2 that assumed for the high-end providers. The spirometry example assumes a 5% service contract.

PERSONNEL TIME PER PROCEDURE: Estimates of time per procedure were gathered from manufacturers, providers, and medical societies, and is stated in fractions of an hour at the top of the worksheet. Ranges for the times were gathered, and the high-end scenarios used the top end of the range. In the example, the spirometry procedure is assumed to take 1/3 of an hour, or 20 minutes.

REQUIRED SQUARE FEET: Estimates of the square feet required for the equipment were gathered from the manufacturers and verified by determining the size of the equipment. The spirometer was determined to occupy 20 square feet of floor space for a high end specialist, as a small room is usually dedicated to the machine for this type of practitioner.

SUPPLY COST PER PROCEDURE: Estimates of supply costs per procedure were gathered from the manufacturers. Volume discounts are sometimes available for supplies, and therefore their price depends on the assumption used for annual volume. For any one scenario, a constant price per procedure can be assumed in the range of the assumed volume. Spirometry for a high-end specialist uses

$2 of supplies per procedure, for a mouthpiece, paper, and printing supplies for the printout of the results.

Work Sheet Calculations

The following describes on a line-by-line basis the calculations performed on the worksheet. The calculations for the normal-return price and normal-return volume worksheets are exactly the same, except that in the former we assume a volume and solve for price, and in the latter we assume a price and solve for volume. The following describes the calculations in the normal-return price version. References are made to the spirometer worksheet example (Table 10) found at the end of this chapter.

Note that the worksheets are a computerized representation of expression (6):

$$= \sum_{t=o}^{T} \frac{(P_t \times Q_t - C_t)(1 - \tau)}{(1 + r)^t} + \sum_{d=1}^{D} \frac{[(K \cdot u)/D]\,\tau}{(1 + r)^d} + \sum_{i=1}^{I} \frac{[K \cdot u \cdot b \left(\frac{I - i + 1}{I}\right)] r_L \tau}{(1 + r_L)^i} \qquad (6)$$

The worksheet puts this somewhat ungainly expression into the easily interpretable form of a cash-flow statement. To "solve" the worksheet for P or Q we must iterate to a solution, just as when we are solving (6) for P or Q. Just as P appears repeatedly in the summation term in (6), it appears repeatedly in the worksheet. The value of P is changed until the NPV = 0. To illustrate, note that in line 1 of the worksheet, P is needed to calculate revenue. In each iteration of the calculation, the worksheet uses a value of P to calculate revenue (and the rest of the worksheet with the other data),

checks the NPV, changes P, and continues in this fashion until NPV = 0. Thus, one cannot intuitively examine the numbers on the worksheet to judge the reasonableness or sensitivity of the zero-NPV price or volume.

Line 1

The revenue from the test is determined by multiplying the break-even price times the volume. The worksheet iterates to a solution for the price necessary to produce revenue sufficient to break even at the assumed volume level.

Line 2

Equipment purchase prices are based on average values for this type of practitioner. Salvage values are based on average values or 10% of initial purchase price if no data was available. Equipment is assumed to be purchased and fully paid for (if not debt financed) at time zero, and salvage value is realized at the end of the last year of useful life. In this example, the average purchase price for a spirometer for this type of practitioner is $8,000, and a 10% salvage value of $800 is realized at the end of year 5. If the equipment were debt financed, an annual repayment schedule would be spread across this line for the life of the loan.

Line 3

All capital expense items in line 2 are multiplied by the percent utilization (listed at the top of the worksheet and defined above) to arrive at the amount on line 3. It is the cash flow in line 3, not line 2, that is included in the net cash flow. In the spirometry example, utilization is assumed to be 30% attributable to this particular procedure code.

Line 4

All operating expenses represent typical values for marginal cost. Costs are marginal in that they arise incrementally as a result of the production of additional units of the procedure being analyzed. The calculations for these items is on the second page of the worksheet. The basic calculation for personnel and supplies is as follows:

MARGINAL UTILIZATION OF RESOURCE PER PROCEDURE x

ANNUAL NUMBER OF PROCEDURES x $ PER UNIT OF RESOURCE

This assumes that the marginal utilization of resource per procedure and $ per unit of resource are constant in the relevant range. This will generally hold for the former. There are some situations in which supplies are less expensive on a per unit basis when a larger volume is purchased; in these situations the per unit cost at the assumed annual volume is used. Maintenance and overhead are defined on an annual basis, and are reduced by the percentage utilization factor. The general form of the calculation is:

COST/UNIT OF RESOURCE x RESOURCE UNITS/YEAR x % UTILIZATION

Line 5

Technician costs are based on the salary for the type of personnel most likely to be performing the test. For spirometry personnel costs, we have the $10.52 hourly wage x .33 hours per procedure x 500 procedures per year = $1,736 per year. Again, hourly wage rates were inflated by 28% to allow for fringe benefits and payroll tax.

Line 6

Supply costs were generally available in the form of $/procedure. The calculation then is: average supply cost/procedure x number of

procedures/year. For the supplies the calculation is $2 per supply "package" x 1 package of supplies per procedure x 500 procedures per year = $1,000 per year.

Line 7

A service contract for spirometers was determined to cost 5% of the initial purchase price per year. For maintenance the unit of resource is a maintenance contract, whose price is the $8,000 purchase price x 5% contract percentage = $400. The annual expense then is $400 per annual contract x 1 contract x 30% utilization = $120 per year.

Line 8

Overhead is defined by number of square feet utilized for the procedure x average overhead/square foot x percentage utilization. The calculations for spirometry overhead are $13.70 per square foot per year x 20 per square foot x 30% utilization for this procedure = $82 per year.

Line 9

Total expenses/year sums line 3 with lines 5 through 8. This captures all the before-tax cash outflows.

Line 10

Taxes are calculated as follows. First we take revenue from line 1, and subtract the total expenses per year from line 9. This figure is multiplied by the marginal tax rate to give us taxes before depreciation. The depreciation tax shield is calculated separately in line 11 as an offset to the tax liability.

Line 11

The depreciation tax shield represents the amount of cash outflow avoided due to the recognition of depreciation as a business expense by the IRS. By purchasing the equipment, the physician has shielded a part of his income in the amount of allowed depreciation expense from income taxation. The tax shield then is computed by taking the allowed annual depreciation times the marginal tax rate (straight-line depreciation is assumed). This tax shield amount is netted against cash outflows in line 11.

Line 12

This sums the total expenses from line 9 with the taxes in line 10, and offsets this total with the depreciation tax shield from line 11. This gives the net cash outflow for the year.

Line 13

Net cash flow is calculated by subtracting the net cash outflow in line 12 from revenue in line 1.

Line 14

In this line we discount the cash flow in each period by the discount factor $(1 + r)^t$. The discounted value for each period is given on this line. This line corresponds to the sum of expressions (3) and (4), that is, all the discounted cash flows except the interest tax shield.

Line 15

The present value of the interest tax shield represents the tax savings on the loan interest for those physicians who borrow to purchase their equipment, discounted back by the interest rate of the loan. The interest

rate on the loan reflects the riskiness of the interest payments, rather than the cost of capital, which reflects the riskiness of the investment. This is analogous to the depreciation shield, except that it is discounted at a different rate. A table showing the calculation of the interest tax shield appears on the second page of the worksheet. For the Spirometry example, no money was borrowed for the equipment so there is no interest tax shield.

Line 16

The net present value equals the sum of all the numbers from line 14 plus the present value of the interest tax shield. In this normal-return approach to the analysis, the technical component price is solved for so that the net present value to the physician of the technical component of the test is always zero (this includes an imputed real rate of return to the physician of 10% per year for the investment of his funds in the equipment). That is, at the given volume, a price is found that will cause all the discounted cash inflows to equal the discounted cash outflows. This line then gives us the final value for expression (6). Lines 1-15 compute various elements of expression (6), and these are all brought together in the NPV of line 16. Given the other data, the worksheet program adjusts the "Technical Component Price" at the top of the worksheet until the NPV in line 16 equals zero. A completely analogous process takes place to calculate normal-return annual volume.

Table 10

INCREMENTAL CASH FLOW ANALYSIS: BREAK-EVEN PRICE FOR TECHNICAL COMPONENT ONLY

| | | | |
|---|---|---|---|
| Diagnostic Technology: | SPIROMETRY | Specialist? | Yes |
| CPT-4 Code(s): | | High-end/Low-end: | High |

INPUT DATA AND ASSUMPTIONS

| | | | |
|---|---|---|---|
| Assumed # Procedures/Yr.: | 500 | Marginal Tax Rate: | 34.50% |
| Hourly Personnel Costs: | $10.52 | Personnel Time/Procedure: | 0.33 |
| Annual Overhead/Square Ft: | $13.70 | Required Square Feet: | 20.00 |
| Annual Maintenance %: | 5.00% | Supply Cost/Procedure: | $2.00 |
| Equipment Purchase Price: | $8,000 | Assumed Useful Life (Yrs): | 5.00 |
| Assumed % Utilization: | 30% | Assumed Cost of Capital: | 10% |
| Assumed % Capital Borrowed: | 0% | Loan Interest Rate: | 6% |
| Technical Component Price: | $7.27 | Net Present Value: | ($0) |

| | Time 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 |
|---|---|---|---|---|---|---|---|---|
| CASH INFLOWS | | | | | | | | |
| 1 Revenue From Test | $0 | $3,633 | $3,633 | $3,633 | $3,633 | $3,633 | $0 | $0 |
| CASH OUTFLOWS | | | | | | | | |
| 2 Equip. purchase & salvage | $8,000 | $0 | $0 | $0 | $0 | ($800) | $0 | $0 |
| 3 x % utilization | $2,400 | $0 | $0 | $0 | $0 | ($240) | $0 | $0 |
| 4 Marginal Op. Expenses/Yr. | | | | | | | | |
| 5 technician | $0 | $1,736 | $1,736 | $1,736 | $1,736 | $1,736 | $0 | $0 |
| 6 supplies | $0 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $0 | $0 |
| 7 maintenance | $0 | $120 | $120 | $120 | $120 | $120 | $0 | $0 |
| 8 overhead | $0 | $82 | $82 | $82 | $82 | $82 | $0 | $0 |
| 9 Total Expenses/Yr. | $2,400 | $2,938 | $2,938 | $2,938 | $2,938 | $2,698 | $0 | $0 |
| 10 Taxes Before Depreciation | $0 | $240 | $240 | $240 | $240 | $323 | $0 | $0 |
| 11 Depreciation Tax Shield | $0 | ($166) | ($166) | ($166) | ($166) | ($83) | $0 | $0 |
| 12 Net Cash Outflow/Yr. | $2,400 | $3,012 | $3,012 | $3,012 | $3,012 | $2,938 | $0 | $0 |
| 13 NET CASH FLOW | ($2,400) | $621 | $621 | $621 | $621 | $695 | $0 | $0 |
| 14 DISCOUNTED CASH FLOW | ($2,400) | $564 | $513 | $466 | $424 | $432 | $0 | $0 |
| 15 PV of Interest Tax Shield | $0.00 (See next page for calculation) | | | | | | | |
| 16 NET PRESENT VALUE AT P (= zero for break-even) | ($0) | | | | | | | |

Table 10 (cont.)

INCREMENTAL CASH FLOW ANALYSIS: BREAK-EVEN PRICE FOR TECHNICAL COMPONENT ONLY

Computation of Annual Operating Expenses

| | TECHNICIAN | SUPPLIES |
|---|---|---|
| COST/UNIT OF RESOURCE | $10.52 | $2.00 |
| X | | |
| RESOURCE UNITS/PROCEDURE | 0.33 | 1.00 |
| X | | |
| PROCEDURES/YEAR | 500 | 500 |
| = ANNUAL COST | $1,736 | $1,000 |

| | OVERHEAD | MAINTENANCE |
|---|---|---|
| COST/UNIT OF RESOURCE | $13.70 | $400 |
| X | | |
| RESOURCE UNITS/YEAR | 20.0 | 1.0 |
| X | | |
| PERCENTAGE UTILIZATION | 30% | 30% |
| = ANNUAL COST | $82 | $120 |

Present Value of Interest Tax Shield
(line 11 on worksheet)

| | Debt Year Start | Int | Tax Shield | PV Tax Shield |
|---|---|---|---|---|
| Year 1 | 0.00 | 0.00 | 0.00 | 0.00 |
| Year 2 | 0.00 | 0.00 | 0.00 | 0.00 |
| Year 3 | 0.00 | 0.00 | 0.00 | 0.00 |
| Year 4 | 0.00 | 0.00 | 0.00 | 0.00 |
| Year 5 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUM | | | | $0.00 |

a. Marginal tax rate is 34.5%
b. Debt principal repaid at year end in equal installments.
c. Interest rate from top of worksheet.
d. Tax shields are discounted at the interest rate of the debt, which assumes they are as risky as the interest payments generating them.

Table 10 (cont.)

INCREMENTAL CASH FLOW ANALYSIS: BREAK-EVEN PRICE FOR TECHNICAL COMPONENT ONLY

SENSITIVITY ANALYSIS: SPIROMETRY

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $7.27 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| HIGH ANN. PROCEDURES | $6.91 | 625 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| LOW ANN. PROCEDURES | $7.86 | 375 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| HIGH COST OF CAPITAL | $7.39 | 500 | 12.50% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| LOW COST OF CAPITAL | $7.14 | 500 | 7.50% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| LOW % UTILIZATION | $6.82 | 500 | 10.00% | 0.00% | 22.50% | $8,000 | $2,938 | 5 |
| HIGH % UTILIZATION | $7.72 | 500 | 10.00% | 0.00% | 37.50% | $8,000 | $2,938 | 5 |
| HIGH % CAP. BORROWED | $7.11 | 500 | 10.00% | 25.00% | 30.00% | $8,000 | $2,938 | 5 |
| HIGH EQUIP. PRICE | $7.67 | 500 | 10.00% | 0.00% | 30.00% | $10,000 | $2,938 | 5 |
| LOW EQUIP. PRICE | $6.86 | 500 | 10.00% | 0.00% | 30.00% | $6,000 | $2,938 | 5 |
| HIGH OP. EXPENSES | $8.74 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $3,673 | 5 |
| LOW OP. EXPENSES | $5.80 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,204 | 5 |
| LONG USEFUL LIFE | $7.12 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 6 |
| SHORT USEFUL | $7.30 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 4 |

## CHAPTER 5: "NORMAL-RETURN" PRICES AND VOLUMES BASED ON RATE-OF-RETURN ANALYSIS

In this section we apply the methods described in the previous chapter in two ways. First, we use estimates of plausible typical volume to calculate current (1988) "normal return" prices for each of the tests, and then compare these estimates with the 1986 BMAD mean charge updated to 1988 by an estimate of inflation in the technical component; the MEI, along with other changes in Medicare prevailing charge limits, is used to make this adjustment. We provide estimates of normal return prices for each test in four scenarios: (1) a specialist with high capital cost assumptions, (2) a specialist with low capital cost assumptions, (3) a non-specialist with high capital cost assumptions, and (4) a non-specialist with low capital cost assumptions. When non-specialists rarely perform a test, we show only the specialist figures. Second, we use the 1986 BMAD mean charge (based on the mean charge of all physicians; see Appendix A, Table 2-1) to estimate what the normal-return volumes would have been in 1986, given this price, for each of the four categories. In this calculation, our 1988 cost figures are "backdated" using the medical component of the CPI, so that all figures are 1986 estimates. (Alternatively, we could have calculated 1988 normal-return volumes based on 1988 costs and an estimate of 1988 BMAD prices. An estimate would have to be used, since we did not have 1988 BMAD data. The sensitivity analysis shows the difference this alternative calculation would have made.)

In the first part of this chapter we show, in summary form, the assumptions we made in various scenarios and the results for each test and each scenario. In subsequent sections we address each test in turn, briefly

describing the test, discussing the rationale for the assumptions, and presenting in Tables 11 through 26 the results of a sensitivity analysis applied to two of the four scenarios: scenarios (1) and (4). Appendix C shows in detail the calculations made for each test.

SUMMARY OF DATA AND ASSUMPTIONS

Table 11 (this and all other tables appear at the end of the chapter) shows the values used in the calculations which follow. We combined the two versions for abdominal echography into a single analysis. In the case of routine EKG, we base our analysis in this section on the codes for tracing and report (HCPCS codes 93005 and 93010).

SUMMARY OF RESULTS

The second column of Table 12 shows prices which would have yielded the 1988 market rate of return for each of the four scenarios. This price can be compared to an estimate of the normal-return technical differential prices with BMAD mean charges updated to 1988, which are reported in the third column. We have indicated the specialty we used for comparison purposes. Finally, the last column of the table shows the annual normal return volume at the average 1986 updated Medicare technical differential for that test.

The results in Table 12 indicate that the test-specialty combinations seem to fall into three groups: those tests for which updated BMAD prices are close to normal-return prices for at least some specialties, those for which updated Medicare prices are well above normal-return prices for all specialties, and those tests for which the price is too high for some specialties. (Holter and real time EKG monitoring are discussed in Chapter 6.)

In the category of tests for which updated Medicare estimated technical differential charges appear unequivocally high compared to normal-return prices, one would include abdominal echography, peripheral vascular testing and ophthalmic biometry. Estimated Medicare technical differential charges frequently exceed our estimates of normal-return prices by factors of three or four or even eight. (One should note, however, that for some of these procedures, relative few BMAD charges were for professional or hospital-site services, so that the estimated differential does not describe the payment experience of a typical doctor.)

In contrast, allowed charges for all X-rays appear to lie in a normal-return range for at least some specialties. This includes chest X-rays, orthopedic X-rays, and upper GI X-rays. The proportion of total operating time used by specific x-rays is, however, fairly imprecise, so that this conclusion is not completely definitive. Should alternative assumptions about division of volume lead to a conclusion that some x-rays are overpriced, it is likely that the same assumptions would suggest that other x-rays are underpriced. EKG and CT scan prices also fall in the appropriate range.

In the third group, updated mean allowed charges are high for some specialties but not for others. Prices are excessive for spirometry for specialists, but not for non-specialists. The spirometry normal-return price for a low cost specialist is $4.54 compared to a mean Medicare updated price of $24.14.

The overall conclusion is that some tests appear, under any reasonable assumption, to have been overpriced. It would be very useful to examine these tests further. Moreover, it would be much more useful, as a matter of cost effective research strategy, to examine them rather than others whose prices

appear to be closer to appropriate levels. Ophthalmic biometry, ultrasound, and peripheral vascular testing, all relatively new and more rapidly diffusing tests, would be the most useful items to begin with. In contrast, pricing of X-rays, EKGs, and CT scans are close to correct.

Of course, even the "correct" tests would be overpriced at higher volumes than those studied here. So even in those cases it would be useful to examine our calculations of normal-return volumes and compare them with the maximum volumes that could feasibly be achieved in practice.

RESULTS FOR SPECIFIC TESTS

In the remainder of this chapter we present, on a test-by-test basis, a more detailed discussion of the rationale for our assumptions and the results we derived. We also show some of the sensitivity analysis.

## 1. SPIROMETRY

### HCPCS CODE 94010

The HCPCS code book defines this test as "Spirometry, including graphic record, total and timed vital capacity, expiratory flow rate measurement(s), and/or maximal voluntary ventilation". It should be noted that above this test the following statement appears: Items 94010-94799 include laboratory procedure(s), interpretation and physician's services (except surgical and anesthesia services as listed in the section on Surgery), unless otherwise stated." This statement seems to imply that this code includes any professional fee, and is therefore always a global fee.

The machines utilized are automated spirometers which measure how well the lungs take in and expel air, and how much air the lungs can hold. Most of

the machines sold today automatically do the calculations which, in the past, might have been done by a technician or the physician. Although there are different technologies utilized in different machines, most machines provide the physician with a record of the patient's performance, as well as predicted values that a patient should have. They all automatically provide the hard copy graphic record which is a requirement of this code. In addition, since the machines are "user friendly" and appear to require little skill to operate, clerical personnel can and do administer the tests.

The cost data gathered was from a wide range of sales representatives who are believed to be knowledgeable about physician practices. A point which consistently came up was the lack of standards for spirometric equipment, as well as for those who administer the tests. Although the American Thoracic Society has published standards, there apparently are no mandated standards for either the equipment or the operators. There is concern that physicians are purchasing equipment which is not reliable to begin with, or are not having their existing machines calibrated and maintained as needed.

The normal return price in 1988 for the technical component for the four cases ranges from $4.54 for a low cost specialist to $20.17 for a high cost non-specialist. The summary table indicates specialty specific price comparisons. Here and in the following sections we discuss only the mean BMAD price for all specialties. The average 1986 BMAD estimated technical differential was calculated by subtracting the hospital professional component from the global mean charge for all specialties. For spirometry this 1986 estimated average technical differential (updated for 1988 to $24.14 by the MEI) was $22.58. The BMAD price therefore substantially exceeds the normal-return price for a low cost, high-volume specialist, but is only modestly in

excess for a high cost, low volume non-specialist. The high cost non-specialist's normal-return price was 4.4 times the price of the low cost specialist. The sensitivity analyses on the normal-return prices reveal that the two factors having the strongest effect for the low cost nonspecialist are volume of procedures done, and the price of the equipment. Prices of the high cost specialist are most sensitive to operating costs.

The average 1986 BMAD implicit technical component fees were used to obtain a normal-return volume for 1986. The results range from 34 procedures to 165 (See Summary Table). The factors which have the greatest impact on the volume as well as the price for the low end non-specialist and the high priced specialist are the price of the equipment and the percent utilization. The sensitivity analysis Tables 13a and 13b illustrate the various options and the results. The calculations underlying the various scenarios for this and all other tests are included in Appendix B.

## 2. OPHTHALMIC BIOMETRY

## HCPCS CODE 76516

The HCPCS code book defines this test as follows: "Ophthalmic biometry by ultrasound echography, A-Mode". This test takes measurements of the eye in order to determine the specifications of a replacement lens prior to cataract surgery. This test is therefore only done by specialists. Some of the machinery being sold today does both A and B scans, but about 80% of the scans done on these machines are still A scans. The test requires that a probe be placed on the eye, and in the past, a great deal of skill was required to administer the test. In the past physicians did the test most of the time,

but new more sophisticated equipment has allowed technicians to administer the test. The calculations on the following pages utilize estimates made by sales representatives. Since this equipment is utilized to such a high extent for the procedure, it is considered inappropriate to assume that a physician with the more sophisticated, more expensive equipment would do less volume. Therefore, volume estimates for both cases are the same. The normal-return prices for the two cases are $16.56 and $32.96. The average 1986 BMAD technical differential adjusted to 1988, is $45.75. This adjustment takes into account the constraints on the global fee for ophthalmic biometry since April 1988. The global fee is now limited to five percent of the fee for ambulatory cataract surgery. A nationwide average level, if all fees were set at the maximum prevailing level, would be approximately $118. This restriction sets the fees for ophthalmic biometry at a lower level than in 1986. Despite the new constraints, the technical differential remains high; either the global fee is high or the hospital-site fee is unusually low.

In both sensitivity analyses, the normal-return price increases the most with the decrease in volume of procedures. The price falls the most with the low equipment prices and low percent of utilization.

When the average 1986 BMAD technical differential is utilized to find the normal-return volume, the low cost specialist requires 26.2 procedures, and the high cost specialist requires 60.5 procedures. The normal-return volume sensitivity analyses reveal that in both cases the volume is most affected by equipment prices and percent utilization. Tables 14a and 14b illustrate the sensitivity analysis.

It should be noted that about 95 percent of these tests were billed as global fees with the office as the site. As one might expect, there were

relative few cases in which the doctor sacrificed the high return on investment in office equipment and accepted just the professional fee. That is, this distribution of tests by site and type of billing is exactly what one would expect if the return on investment in office equipment were extraordinarily high. The "non-global" frequency is large enough to calculate a meaningful average, and it shows precisely what one would have expected.

### 3. ABDOMINAL ECHOGRAPHY

### HCPCS CODE 76700

The HCPCS code book defines 76700 as follows: "Echography, abdominal, B-Scan and/or real time with image documentation; complete." Code 76705 is "limited (e.g., single organ, quadrant, follow-up). Although these codes include B-scan, the equipment which is manufactured today does not utilize this, apparently obsolete, technology. All equipment sold today does tests in real time. The technology can be phased or sectored, and many of the machines can be enhanced to do additional procedures with the addition of specialized attachments. The abdominal tests can be done on machines that range in price from hundreds of dollars to over hundred thousand dollars. The following calculations are based on what physicians most commonly purchase, according to the sales representatives.

The four cases reveal normal-return prices which range from $15.42 to $48.28. The 1986 BMAD technical differential for this test, updated by the MEI was $77.03. The highest cost non-specialist normal-return price was more than three times the low cost specialist's price. The sensitivity analysis

revealed that high operating costs resulted in the highest normal-return prices in both cases.

When the average 1986 BMAD fees (CPI updated) were used to ascertain the normal-return volumes, the figures ranged from 38.1 procedures to 135.3.

The normal-return volume sensitivity analysis reveals that the factors having the greatest effect for the low cost non-specialist as well as the high cost specialist are the price of the equipment and the percentage utilization (see Tables 15a and 15b).

## 4. ELECTROCARDIOGRAM

### HCPCS CODES 93005, 93010

The 12-lead electrocardiogram is a standard diagnostic technology used by cardiologists and non-specialists. The electrocardiograph machines vary in price, in this analysis from $4000 to $13,000, based on prices obtained from manufacturers. The equipment has a fairly long life for medical equipment, and is assumed here the useful life ranges from 8 to 12 years. The personnel used to perform the test could be an l.p.n., technician, or R.N.; specialists are assumed to use the more expensive R.N.s. Personnel time to perform the procedure was obtained from the manufacturers, and varied from 5 to 12 minutes. Supplies for the procedure were assumed to cost $5 per procedure, again based on manufacturers information.

The normal-return price was found to range from $8.17 for a low-end non-specialist to $14.63 for a high-end non-specialist. This compares to an updated BMAD mean technical differential of $8.90. This procedure appears to be in the range of normal-return prices.

High end non-specialists had a higher normal-return price than a high-end specialist due to the large difference in the number of procedures assumed. In this case the far larger volume of test for specialists (700 per year vs. 170 per year based on the previously cited Mendenhall medical practice data) overwhelmed the effect of the higher equipment price. Both the low-end non-specialist and the high-end specialist had normal-return prices most sensitive to operating expenses. A 25% change in operating expenses caused the low-end non-specialist's breakeven price to range from $6.43 to $9.92, while the high-end specialist's went from $11.36 to $16.47. Normal-return price is nearly as sensitive to equipment price and annual procedures as it is to operating expenses. See Tables 16a and 16b for sensitivity analysis results.

## 5. NON-INVASIVE PERIPHERAL VASCULAR TESTING

### HCPCS CODE 93910

The HCPCS code book defines this test as follows: "Non-invasive studies of lower extremity arteries (e.g., segmental blood pressure measurements, continuous wave Doppler analog wave form analysis, evocative pressure response to exercise or reactive hyperemia, photoplethysmography or pulse volume digit wave form analysis, flow velocity signals)". As can be seen from this definition, there are a number of different ways of performing a lower arterial vascular test, which has resulted in some confusion. The test can be done on equipment costing a few hundred dollars, all the way up to equipment costing over $150,000, with each providing varying amounts and types of information. These different types of equipment basically do different tests, require different levels of skills on the part of the operator, and take

varying amounts of time and resources. Information was obtained from sales representatives as well as from people running vascular labs. There was a great deal of concern expressed about the unfairness of this situation and the room for possible abuses. The numbers used in the following calculations represent what is most commonly being purchased by physicians, according to sales representatives in the field. The volume figures remain tentative.

The normal-return prices for the four cases range from $10.62 for the low cost non-specialist, to $25.97 for the high cost specialist. The average 1986 BMAD technical differential for this code was $68.88 updated by the MEI. There appears to be substantial overpayment for the technical component. For the low cost non-specialist the biggest impact is seen in the changes in the operating expenses. For the high cost specialist, the biggest impact is seen in decreasing the volume.

When the average 1986 CPI updated BMAD fees were used to ascertain the normal-return volume, numbers ranged from 15 to 117.6. The normal-return volume sensitivity analyses in Tables 17a and 17b, revealed that the factors having the greatest effect are the price of the equipment and the percent utilization.

6. CHEST, ORTHOPEDIC AND UPPER G.I. X-RAYS

CODES

71010 - CHEST, 1 VIEW X-RAY
71020 - CHEST, 2 VIEWS
72170- PELVIS
73020 - SHOULDER
73510 - HIP
73560 - KNEE
73620 - FOOT
74240 - UPPER G.I.

In order to estimate the volume of X-rays performed by physicians, the 1981 study of Robert Mendenhall was utilized to provide volume estimates. All of the X-rays are grouped together in this section because of the derivation of the volume figures from the Mendenhall study. Mendenhall provides data on certain tests ordered by physician, by specialty. His data on chest "chest X-ray, and "G.I. X-ray" were utilized. Mendenhall's data provided us with volume estimates on chest and upper G.I., but did not provide data on the volume of the specific orthopedic X-rays. The sales representatives felt chest X-rays were 30% of the X-rays done. In order to determine the proportion of each of the orthopedic X-rays currently being studied, the total number of such X-rays in the BMAD data was calculated. These 5 (pelvis, shoulder, hip, knee, and foot), being among the most common X-rays, were assumed to account for 50% of the remaining X-rays. By assuming that these orthopedic X-rays were 50% of the total X-rays done, the proportion (of the total number of X-rays we are studying in the BMAD data) of each orthopedic X-rays was found. For the chest X-ray analysis the internist is considered the generalist or the non-specialist, and the pulmonologist is considered the specialist. For the orthopedic X-rays, the internist is once again considered the generalist or non-specialist. For the upper G.I. tests, there is no generalist, and the gastroenterologist is considered the specialist. Once the

proportion of orthopedic X-rays was determined, they were applied to Mendenhall's overall orthopedic volume numbers, which resulted in the volume figures used on the following pages.

In most of the cases, the BMAD updated prices were close to the low end of the range of normal-return prices and sometimes below them; for example, the average Medicare MEI updated price for pelvis X-ray was $19.27, which is below the normal-return price of $20.37 received by a low end specialist.

The normal-return volume analysis revealed that for one view chest X-rays the range was 97.72 to 376. For double view X-rays the range was from 60.8 to 428 X-rays, for Pelvis X-rays the range was from 31.1 to 119.5 procedures. For hip X-rays the range was from 62.6 to 172 procedures. For knee X-rays the range was from 99.2 to 395.8, and for upper G.I. the range was from 293.6 to 506.8. The sensitivity analysis for breakeven volume was not done for shoulder (73020, 73030) and foot (73620, 73630) since figures from the BMAD data were not available for these two procedures.

The sensitivity analysis of the X-rays (see Tables 18a-25b) reveals that the factors having the greatest influence are percent utilization, high operating expenses, and long useful life.

## 7. C.T. SCANNERS

### HCPCS CODE 70470

The HCPCS code book defines this test as "computerized axial tomography, head or brain without contrast material, followed by contrast material(s) and further sections". There are some machines which do only heads, but all the

equipment being sold today performs both head and body tomography. The problem of obsolescence is diminishing as the industry matures.

The input data and assumptions for the cash flow analysis presented in Tables 26a and 26b is based on information gathered from a number of sources. Manufacturers representatives from the companies having the largest market shares of the equipment being studied were contacted in the belief that they would be knowledgeable about what physicians were purchasing, and about how these pieces of equipment were being utilized in the physician's practices.

The normal-return prices are $129 and $223.77. The average 1986 BMAD technical differential was $174.96 when updated by the MEI. As shown in Table 2-1 in Appendix A, this relatively low profit in office testing is associated with relatively few tests done in the office. This pattern is consistent with choice of site being influenced by profitability considerations, although the high initial cost of CT equipment probably also accounts for their infrequent use in the office setting. The normal-return price sensitivity analysis (see Tables 26a and 26b) reveals that the high cost specialist's normal-return price increases the most with low percentage utilization, and with high equipment costs. The low cost specialist's breakeven price increases the most with a decrease in the number of procedures, and decreases the most with a decrease in operation costs.

Table 11
COST INFORMATION BY CPT CODES

EQUIPMENT COSTS

| | Name of Equipment | Purchase Price | | Est. Useful Life | % Utiliz This Proc. |
|---|---|---|---|---|---|
| SPIROMETRY<br>94010-Spirometry | automated spirometer with microprocessor | Non-Spec<br>Spec | $4,000<br>$8,000 | 5 years | Non-Spec 90%<br>Spec 30% |
| OPHTHALMIC BIOMETRY BY ULTRASOUND<br>76516-echography, A-mode | A-Mode ophthalmic scanner | Spec Low<br>Spec High | $6,250<br>$12,000 | 5 years | Spec. 70-90% |
| ABDOMINAL ECHOGRAPHY<br>76700-B scan or real time<br>76705-single organ, quadrant, follow up | real time abdominal scanner | Non-Spec Low<br>Non-Spec High<br>Spec Low<br>Spec High | $20,000<br>$30,000<br>$65,000<br>$85,000 | 5 years | <br>Non-Spec 60%<br>Spec 40% |
| PERIPHERAL VASCULAR<br>93910-Artery, Lower | noninvasive ultrasonic vascular assessment system | Non-Spec Low<br>Non-Spec High<br>Spec Low<br>Spec High | $5,000<br>$7,000<br>$70,000<br>$90,000 | 5 years | <br>Non-Spec 30%<br>Spec 60% |
| CHEST & ORTHOPEDIC X-RAYS<br>71010-single view, frontal<br>71020-frontal & lateral<br>72170-Pelvis, anteroposterio<br>73020-Shoulder, one view<br>73510-Hip, complete, min 2<br>73560-Knee antepost. & lateral<br>73620-Foot, antepost & lateral | non-fluroscopic x-ray machine | Non-Spec Low<br>Non-Spec High<br>Spec Low<br>Spec High | $50,000<br>$60,000<br>$90,000<br>$100,000 | 10 years | 10.0%<br>20.0%<br>4.5%<br>6.8%<br>15.1%<br>12.9%<br>10.7% |
| UPPER G.I.<br>74240-w or w/o delayed film, w/o KUB | fluoroscopic x-ray machine | Spec Low<br>Spec High | $150,000<br>$200,000 | 10 years | Spec 50% |
| CT SCAN OF HEAD OR BRAIN<br>70470-Head w/o then w contrast | whole body CT scanner | Spec Low<br>Spec High | $500,000<br>$800,000 | 7 years | Spec 60% |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Tape | holter analog recorder | Low<br>High | 1000-1200<br>1800-2100 | 5-7 years | 100% |
| SUPERIMPOSITION SCANNING & RPT<br>93262 (Q0021) Tape Scanning | holter scanner | Low<br>High | 30,000-35,000<br>55,000-60,000 | 6-10 years | 100% |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Chip | holter digital recorder | Low<br>High | 10,000-12,000<br>18,000-22,000 | 4-6 years | 100% |
| COMPUTER ANALYSIS & REPORT<br>93262 (Q0021) From Chip Memory | personal computer, software, printer | Low<br>High | 500<br>5000 | 5-8 years | 25-100% |
| REAL TIME ANALYSIS<br>93266 (Q0028) | real time monitor | Low<br>High | 5000-6000<br>8000-12,000 | 4-6 years | 100% |
| ELECTROCARDIOGRAM<br>93005 12 Lead EKG hookup/disc | electrocardiograph 12 lead | Low<br>High | 4000<br>13,000 | 8-12 years | 100% |

Table 11 (cont.)
COST INFORMATION BY CPT CODES

PERSONNEL COSTS

| | VOLUME/YEAR | Maintenance cost/year | Time/ procedure | Type of Employee Performing Service |
|---|---|---|---|---|
| SPIROMETRY<br>94010-Spirometry | Non-Spec Low Cost 400<br>Non-Spec High Cost 100<br>Spec Low Cost 1000<br>Spec High Cost 500 | Low 2.5%<br>High 5.0% | .33 hours | Non-Spec Low skill tech<br>Spec Low skill tech |
| OPHTHALMIC BIOMETRY BY ULTRASOUND<br>76516-echography, A-mode | Spec Low Cost 150<br>Spec High Cost 150 | Low 3.5%<br>High 7.0% | .25 hours | Spec High skill tech |
| ABDOMINAL ECHOGRAPHY<br>76700-B scan or real time<br>76705-single organ, quadrant, follow up | 76700<br>Non-Spec Low Cost 500<br>Non-Spec High Cost 150<br>Spec Low Cost 1000<br>Spec High Cost 5000 | Low 4.0%<br>High 8.0% | .67 hours | Non-Spec Low skill tech<br>Spec High skill tech |
| PERIPHERAL VASCULAR<br>93910-Artery, Lower | Non-Spec Low Cost 300<br>Non-Spec High Cost 150<br>Spec Low Cost 1300<br>Spec High Cost 500 | Low 3.5%<br>High 7.0% | .5 hours | Non-Spec Low skill tech<br>Spec High skill tech |
| CHEST & ORTHOPEDIC X-RAYS<br>71010-single view, frontal<br>71020-frontal & lateral<br>72170-Pelvis, anteroposterior<br>73020-Shoulder, one view<br>73510-Hip, complete, min 2<br>73560-Knee antepost. & lateral<br>73620-Foot, antepost & lateral | Non-Spec Spec<br>142 210<br>283 428<br>8 71<br>11 106<br>22 200<br>18 166 | Low 5.0%<br>High 10.0% | .33 hours<br>.42<br>.33<br>.33<br>.42<br>.42<br>.42 | Non-Spec Low skill tech<br>Spec High skill tech |
| UPPER G.I.<br>74240-w or w/o delayed film, w/o KUB | Non-Spec Spec<br>333 333 | Low 5.0%<br>High 10.0% | .5 hour | Spec High skill tech |
| CT SCAN OF HEAD OR BRAIN<br>70470-Head w/o then w contrast | Spec Low Cost 1560<br>Spec High Cost 1000 | Low 7.5%<br>High 10.0% | .66 hours | Spec High skill tech |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Tape | 250 maximum | 5-10%<br>Service Cont. | .75 hours | Tech/Nurse/Office |
| SUPERIMPOSITION SCANNING & RPT<br>93262 (Q0021) Tape Scanning | 8/day maximum<br>commonly much lower | 5-10%<br>Service Cont. | 1 hour | Tech/Nurse |
| AMBULATORY CARDIAC MONITORING<br>93262 (Q0020) Continuous Chip | 250 maximum | 5-10%<br>Service Cont. | .75 hour | Tech/Nurse/Office |
| COMPUTER ANALYSIS & REPORT<br>93262 (Q0021) From Chip Memory | 8/day maximum<br>commonly much lower | 5-10%<br>Service Cont. | .25 hour | Tech/Nurse/Office |
| REAL TIME ANALYSIS<br>93266 (Q0026) | 250 maximum | 5-10% service contract | .75 hour<br>High 10-12 mins | Tech/Nurse/Office |
| ELECTROCARDIOGRAM<br>93005 12 Lead EKG hookup/disc | 170-850 | 5-10% service contract | Low 3-5 mins.<br>High 10-12 mins | Nurse/Tech |

Table 11 (cont.)
COST INFORMATION BY CPT CODES

| | Hourly Wage | Supplies/ procedure |
|---|---|---|
| SPIROMETRY | | |
| 94010-Spirometry | 10.62/hour | Low Cost<br>High Cost |
| OPHTHALMIC BIOMETRY BY ULTRASOUND | 16.04/hour | Low Cost |
| 76516-echography, A-mode | | High Cost |
| ABDOMINAL ECHOGRAPHY | 10.52/hour | Low Cost |
| 76700-B scan or real time | 16.04/hour | High Cost |
| 76705-single organ, quadrant, follow up | | |
| PERIPHERAL VASCULAR | 10.52/hour | Low Cost |
| 93910-Artery, Lower | 16.04/hour | High Cost |
| CHEST & ORTHOPEDIC X-RAYS | | Low |
| 71010-single view, frontal | 10.52/hour | 3.75 |
| 71020-frontal & lateral | 16.04/hour | 5.50 |
| 72170-Pelvis, anteroposterior | | 3.75 |
| 73020-Shoulder, one view | | 3.75 |
| 73510-Hip, complete, min 2 | | 5.50 |
| 73560-Knee antepost. & lateral | | 5.50 |
| 73620-Foot, antepost & lateral | | 5.50 |
| UPPER G.I. | | Low Cost |
| 74240-w or w/o delayed film, w/o KUB | 16.04/hour | High Cost |
| CT SCAN OF HEAD OR BRAIN | | Low Cost |
| 70470-Head w/o then w contrast | 16.04/hour | High Cost |
| AMBULATORY CARDIAC MONITORING | Low 10/hour | |
| 93262 (Q0020) Continuous Tape | High 16/hour | $9-11 |
| SUPERIMPOSITION SCANNING & RPT | Low 10/hour | $2 |
| 93262 (Q0021) Tape Scanning | High 16/hour | |
| AMBULATORY CARDIAC MONITORING | Low 10/hour | $9-11 |
| 93262 (Q0020) Continuous Chip | High 16/hour | |
| COMPUTER ANALYSIS & REPORT | Low 8/hour | $1-2 |
| 93262 (Q0021) From Chip Memory | High 16/hour | |
| REAL TIME ANALYSIS | Low 10/hour | $5 |
| 93266 (Q0028) | High 16/hour | |

Table 12
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|
| CODE: 94010<br>DESCRIPTION: SPIROMETRY | | | | | | | |
| Non-specialist low | 100 | 15.59 | | Int. Med. 22.79 | 52.9 | Procedures | 13.23 - 19.53 |
| Non-specialist high | 100 | 20.17 | | | 165 | | |
| | | | 24.14 | | | | |
| Specialist low | 1000 | 4.54 | | | 34 | | |
| Specialist high | 500 | 7.27 | | Pulm. Dis. 23.75 | 43.4 | Oper. Exp. | 5.80 - 8.74 |
| CODE: 76516 (3)<br>DESCRIPTION: OPHTH. BIOMETRY | | | | | | | |
| Non-specialist low | | | | | | | |
| Non-specialist high | | | | | | | |
| | | | 45.75 | | | | |
| Specialist low | 150 | 16.56 | | Ophth. 40.28 | 26.2 | Procedures | 14.06 - 20.73 |
| Specialist high | 150 | 32.96 | | | 60.5 | Procedures | 27.19 - 42.58 |
| CODE: 76700<br>DESCRIPTION: ULTRASOUND | | | | | | | |
| Non-specialist low | 500 | 15.42 | | Int. Med. 86.12 | 38.1 | Oper. Exp. | 12.78 - 18.07 |
| Non-specialist high | 150 | 48.28 | | | 75 | | |
| | | | 77.03 | | | | |
| Specialist low | 1000 | 19.43 | | | 84 | | |
| Specialist high | 500 | 33.47 | | Rad. 73.97 | 135.3 | Procedures | 29.52 - 40.04 |
| CODE: 93910<br>DESCRIPTION: NON-INV PER VASCULAR | | | | | | | |
| Non-specialist low | 300 | 10.62 | | Int. Med. 79.90 | 15 | Oper. Exp. | 8.69 - 12.55 |
| Non-specialist high | 150 | 22.71 | | | 32.7 | | |
| | | | 68.88 | | | | |
| Specialist low | 1300 | 13.74 | | | 75 | | |
| Specialist high | 500 | 25.97 | | Gen. Surg. 56.55 | 117.6 | Procedures | 22.98 - 30.95 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"
(3) In April 1988, the allowed charge for ophthalmic biometry was restricted to 5% of the average allowed charge for cataract removal, HCPCS Code 66984

Table 12 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|---|
| CODE: 71010<br>DESCRIPTION: CHEST X-RAY 1 VIEW | | | | | | | | |
| Non-specialist low | 142 | 13.72 | | Int. Med. | 19 | 97.72 | Oper. Exp. | 11.12 - 16.33 |
| Non-specialist high | 142 | 18.60 | | | | 177.5 | | |
| | | | 15.19 | | | | | |
| Specialist low | 210 | 16.50 | | | | 205.3 | | |
| Specialist high | 210 | 21.32 | | Rad. | 9.86 | 376 | Oper. Exp. | 17.10 - 25.53 |
| CODE: 71020<br>DESCRIPTION: CHEST X-RAY 2 VIEWS | | | | | | | | |
| Non-specialist low | 283 | 13.18 | | Int. Med. | 24.28 | 60.8 | Oper. Exp. | 10.30 - 16.06 |
| Non-specialist high | 283 | 19.57 | | | | 131.8 | | |
| | | | 22.62 | | | | | |
| Specialist low | 428 | 19.61 | | | | 177.6 | | |
| Specialist high | 428 | 25.12 | | Rad. | 23.67 | 428.5 | Oper. Exp. | 19.95 - 30.30 |
| CODE: 72170<br>DESCRIPTION: PELVIS X-RAY | | | | | | | | |
| Non-specialist low | 8 | 58.97 | | Int. Med. | 20.23 | 31.1 | Procedures | 48.62 - 76.18 |
| Non-specialist high | 8 | 85.62 | | | | 53 | | |
| | | | 19.27 | | | | | |
| Specialist low | 71 | 20.37 | | Ortho. | 17.71 | 69.9 | | |
| Specialist high | 71 | 26.19 | | Rad. | 21.42 | 119.5 | Oper. Exp. | 21.12 - 31.27 |
| CODE: 73510<br>DESCRIPTION: HIP X-RAY | | | | | | | | |
| Non-specialist low | 25 | 65.89 | | Int. Med. | 26.52 | 86.8 | Procedures | 54.70 - 84.54 |
| Non-specialist high | 25 | 95.22 | | | | 152.1 | | |
| | | | 22.82 | | | | | |
| Specialist low | 235 | 22.34 | | Ortho. | 19.56 | 172.1 | | |
| Specialist high | 235 | 28.98 | | Rad. | 25.80 | 62.6 | Oper. Exp. | 23.25 - 34.71 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 12 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|---|
| CODE: 73020<br>DESCRIPTION: SHOULDER X-RAY | | | | | | | | |
| Non-specialist low | 11 | 64.18 | | Int. Med. | 23.06 | N.A. | Procedures | 52.78 - 83.14 |
| Non-specialist high | 11 | 93.90 | | | | N.A. | | |
| | | | 20.51 | | | | | |
| Specialist low | 106 | 19.06 | | Ortho. | 19.11 | N.A. | | |
| Specialist high | 106 | 24.94 | | Rad. | 22.65 | N.A. | Procedures | 22.11 - 29.66 |
| CODE: 73560<br>DESCRIPTION: KNEE X-RAY | | | | | | | | |
| Non-specialist low | 22 | 64.17 | | Int. Med. | 22.09 | 99.2 | Procedures | 53.32 - 82.25 |
| Non-specialist high | 22 | 92.70 | | | | 182 | | |
| | | | 19.78 | | | | | |
| Specialist low | 200 | 22.36 | | Ortho. | 19.16 | 208 | | |
| Specialist high | 200 | 29.01 | | Rad. | 21.78 | 395.8 | Oper. Exp. | 23.28 - 34.75 |
| CODE: 73620<br>DESCRIPTION: FOOT X-RAY | | | | | | | | |
| Non-specialist low | 18 | 64.84 | | | | | Oper. Exp. | 55.58 - 74.08 |
| Non-specialist high | 18 | 93.70 | | | | | | |
| | | | 17.85 | | | | | |
| Specialist low | 166 | 22.34 | | Ortho. | 16.61 | | | |
| Specialist high | 166 | 28.99 | | Rad. | 19.33 | | Oper. Exp. | 23.25 - 34.72 |
| CODE: 74240<br>DESCRIPTION: UPPER G.I. X-RAY | | | | | | | | |
| Non-specialist low | | | | | | | | |
| Non-specialist high | | | | | | | | |
| | | | 57.45 | | | | | |
| Specialist low | 333 | 57.21 | | | | 293.6 | Procedures | 49.77 - 69.61 |
| Specialist high | 333 | 82.64 | | Rad. | 59.64 | 506.8 | Procedures | 70.72 - 102.52 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 12 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS: NORMAL-RETURN PRICE FOR TECHNICAL COMPONENT ONLY

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|
| CODE: 70470<br>DESCRIPTION: C.T. SCAN | | | | | | | |
| Non-specialist low | | | | | | | |
| Non-specialist high | | | | | | | |
| | | | 210.24 | | | | |
| Specialist low | 1560 | 129 | | | 503.2 | Oper. Exp. | 104.10 - 153.91 |
| Specialist high | 1000 | 223.77 | | Rad. 207.10 | 966.8 | Procedures | 198.42 - 266.02 |
| CODE: 93005<br>DESCRIPTION: ELECTROCARDIOGRAM, TRACING ONLY | | | | | | | |
| Non-specialist low | 425 | 8.17 | | | 212 | Oper. Exp. | 6.43 - 9.92 |
| Non-specialist high | 170 | 14.63 | | | 379 | | |
| | | | 8.90 | N.A. | | | |
| Specialist low | 850 | 9.27 | | | 761 | | |
| Specialist high | 700 | 13.92 | | | 2955 | | 11.36 - 16.47 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 13a

SENSITIVITY ANALYSIS: SPIROMETRY

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $15.59 | 100 | 10.00% | 0.00% | 90.00% | $4,000 | $974 | 5 |
| HIGH ANN. PROCEDURES | $13.23 | 125 | 10.00% | 0.00% | 90.00% | $4,000 | $974 | 5 |
| LOW ANN. PROCEDURES | $19.53 | 75 | 10.00% | 0.00% | 90.00% | $4,000 | $974 | 5 |
| HIGH COST OF CAPITAL | $16.54 | 100 | 12.50% | 0.00% | 90.00% | $4,000 | $974 | 5 |
| LOW COST OF CAPITAL | $14.67 | 100 | 7.50% | 0.00% | 90.00% | $4,000 | $974 | 5 |
| LOW % UTILIZATION | $12.64 | 100 | 10.00% | 0.00% | 67.50% | $4,000 | $974 | 5 |
| HIGH % UTILIZATION | $16.90 | 100 | 10.00% | 0.00% | 100.00% | $4,000 | $974 | 5 |
| HIGH % CAP. BORROWED | $14.63 | 100 | 10.00% | 25.00% | 90.00% | $4,000 | $974 | 5 |
| HIGH EQUIP. PRICE | $18.42 | 100 | 10.00% | 0.00% | 90.00% | $5,000 | $974 | 5 |
| LOW EQUIP. PRICE | $12.76 | 100 | 10.00% | 0.00% | 90.00% | $3,000 | $974 | 5 |
| HIGH OP. EXPENSES | $16.88 | 100 | 10.00% | 0.00% | 90.00% | $4,000 | $1,217 | 5 |
| LOW OP. EXPENSES | $14.30 | 100 | 10.00% | 0.00% | 90.00% | $4,000 | $730 | 5 |
| LONG USEFUL LIFE | $14.48 | 100 | 10.00% | 0.00% | 90.00% | $4,000 | $730 | 6 |
| SHORT USEFUL LIFE | $15.87 | 100 | 10.00% | 0.00% | 90.00% | $4,000 | $730 | 4 |

Table 13b

SENSITIVITY ANALYSIS : SPIROMETRY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $7.27 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| HIGH ANN. PROCEDURES | $6.91 | 625 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| LOW ANN. PROCEDURES | $7.86 | 375 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| HIGH COST OF CAPITAL | $7.39 | 500 | 12.50% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| LOW COST OF CAPITAL | $7.14 | 500 | 7.50% | 0.00% | 30.00% | $8,000 | $2,938 | 5 |
| LOW % UTILIZATION | $6.82 | 500 | 10.00% | 0.00% | 22.50% | $8,000 | $2,938 | 5 |
| HIGH % UTILIZATION | $7.72 | 500 | 10.00% | 0.00% | 37.50% | $8,000 | $2,938 | 5 |
| HIGH % CAP. BORROWED | $7.11 | 500 | 10.00% | 25.00% | 30.00% | $8,000 | $2,938 | 5 |
| HIGH EQUIP. PRICE | $7.67 | 500 | 10.00% | 0.00% | 30.00% | $10,000 | $2,938 | 5 |
| LOW EQUIP. PRICE | $6.86 | 500 | 10.00% | 0.00% | 30.00% | $6,000 | $2,938 | 5 |
| HIGH OP. EXPENSES | $8.74 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $3,673 | 5 |
| LOW OP. EXPENSES | $5.80 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,204 | 5 |
| LONG USEFUL LIFE | $7.12 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 6 |
| SHORT USEFUL | $7.30 | 500 | 10.00% | 0.00% | 30.00% | $8,000 | $2,938 | 4 |

Table 14a

SENSITIVITY ANALYSIS: OPHTH BIOMETRY

Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $16.56 | 150 | 10.00% | 0.00% | 90.00% | $6,250 | $855 | 5 |
| HIGH ANN. PROCEDURES | $14.06 | 187.5 | 10.00% | 0.00% | 90.00% | $6,250 | $855 | 5 |
| LOW ANN. PROCEDURES | $20.73 | 112.5 | 10.00% | 0.00% | 90.00% | $6,250 | $855 | 5 |
| HIGH COST OF CAPITAL | $17.56 | 150 | 12.50% | 0.00% | 90.00% | $6,250 | $855 | 5 |
| LOW COST OF CAPITAL | $15.60 | 150 | 7.50% | 0.00% | 90.00% | $6,250 | $855 | 5 |
| LOW % UTILIZATION | $13.44 | 150 | 10.00% | 0.00% | 67.50% | $6,250 | $855 | 5 |
| HIGH % UTILIZATION | $17.95 | 150 | 10.00% | 0.00% | 100.00% | $6,250 | $855 | 5 |
| HIGH % CAP. BORROWED | $15.56 | 150 | 10.00% | 25.00% | 90.00% | $6,250 | $855 | 5 |
| HIGH EQUIP. PRICE | $19.61 | 150 | 10.00% | 0.00% | 90.00% | $7,813 | $855 | 5 |
| LOW EQUIP. PRICE | $13.52 | 150 | 10.00% | 0.00% | 90.00% | $4,688 | $855 | 5 |
| HIGH OP. EXPENSES | $17.99 | 150 | 10.00% | 0.00% | 90.00% | $6,250 | $1,069 | 5 |
| LOW OP. EXPENSES | $15.14 | 150 | 10.00% | 0.00% | 90.00% | $6,250 | $641 | 5 |
| LONG USEFUL LIFE | $13.98 | 150 | 10.00% | 0.00% | 90.00% | $6,250 | $641 | 6 |
| SHORT USEFUL LIFE | $15.43 | 150 | 10.00% | 0.00% | 90.00% | $6,250 | $641 | 4 |

Table 14b

SENSITIVITY ANALYSIS: OPHTH BIOMETRY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $32.96 | 150 | 10.00% | 0.00% | 90.00% | $12,000 | $1,816 | 5 |
| HIGH ANN. PROCEDURES | $27.19 | 187.5 | 10.00% | 0.00% | 90.00% | $12,000 | $1,816 | 5 |
| LOW ANN. PROCEDURES | $42.58 | 112.5 | 10.00% | 0.00% | 90.00% | $12,000 | $1,816 | 5 |
| HIGH COST OF CAPITAL | $34.87 | 150 | 12.50% | 0.00% | 90.00% | $12,000 | $1,816 | 5 |
| LOW COST OF CAPITAL | $31.11 | 150 | 7.50% | 0.00% | 90.00% | $12,000 | $1,816 | 5 |
| LOW % UTILIZATION | $25.75 | 150 | 10.00% | 0.00% | 67.50% | $12,000 | $1,816 | 5 |
| HIGH % UTILIZATION | $36.17 | 150 | 10.00% | 0.00% | 100.00% | $12,000 | $1,816 | 5 |
| HIGH % CAP. BORROWED | $31.04 | 150 | 10.00% | 25.00% | 90.00% | $12,000 | $1,816 | 5 |
| HIGH EQUIP. PRICE | $39.44 | 150 | 10.00% | 0.00% | 90.00% | $15,000 | $1,816 | 5 |
| LOW EQUIP. PRICE | $26.49 | 150 | 10.00% | 0.00% | 90.00% | $9,000 | $1,816 | 5 |
| HIGH OP. EXPENSES | $33.99 | 150 | 10.00% | 0.00% | 90.00% | $12,000 | $2,270 | 5 |
| LOW OP. EXPENSES | $29.94 | 150 | 10.00% | 0.00% | 90.00% | $12,000 | $1,362 | 5 |
| LONG USEFUL LIFE | $27.72 | 150 | 10.00% | 0.00% | 90.00% | $12,000 | $1,362 | 6 |
| SHORT USEFUL LIFE | $30.49 | 150 | 10.00% | 0.00% | 90.00% | $12,000 | $1,362 | 4 |

Table 15a

SENSITIVITY ANALYSIS: ABDMNL ECHOGRAPHY

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $15.42 | 500 | 10.00% | 75.00% | 60.00% | $20,000 | $5,287 | 5 |
| HIGH ANN. PROCEDURES | $14.25 | 625 | 10.00% | 75.00% | 60.00% | $20,000 | $5,287 | 5 |
| LOW ANN. PROCEDURES | $17.38 | 375 | 10.00% | 75.00% | 60.00% | $20,000 | $5,287 | 5 |
| HIGH COST OF CAPITAL | $15.58 | 500 | 12.50% | 75.00% | 60.00% | $20,000 | $5,287 | 5 |
| LOW COST OF CAPITAL | $15.27 | 500 | 7.50% | 75.00% | 60.00% | $20,000 | $5,287 | 5 |
| LOW % UTILIZATION | $13.89 | 500 | 10.00% | 75.00% | 45.00% | $20,000 | $5,287 | 5 |
| HIGH % UTILIZATION | $17.00 | 500 | 10.00% | 75.00% | 75.00% | $20,000 | $5,287 | 5 |
| HIGH % CAP. BORROWED | $14.90 | 500 | 10.00% | 93.75% | 60.00% | $20,000 | $5,287 | 5 |
| HIGH EQUIP. PRICE | $16.88 | 500 | 10.00% | 75.00% | 60.00% | $25,000 | $5,287 | 5 |
| LOW EQUIP. PRICE | $13.97 | 500 | 10.00% | 75.00% | 60.00% | $15,000 | $5,287 | 5 |
| HIGH OP. EXPENSES | $18.07 | 500 | 10.00% | 75.00% | 60.00% | $20,000 | $6,609 | 5 |
| LOW OP. EXPENSES | $12.78 | 500 | 10.00% | 75.00% | 60.00% | $20,000 | $3,965 | 5 |
| LONG USEFUL LIFE | $14.96 | 500 | 10.00% | 75.00% | 60.00% | $20,000 | $3,965 | 6 |
| SHORT USEFUL LIFE | $15.61 | 500 | 10.00% | 75.00% | 60.00% | $20,000 | $3,965 | 4 |

Table 15b

SENSITIVITY ANALYSIS: ABDMNL ECHOGRAPHY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $33.47 | 500 | 10.00% | 75.00% | 40.00% | $85,000 | $10,032 | 5 |
| HIGH ANN. PROCEDURES | $29.52 | 625 | 10.00% | 75.00% | 40.00% | $85,000 | $10,032 | 5 |
| LOW ANN. PROCEDURES | $40.04 | 375 | 10.00% | 75.00% | 40.00% | $85,000 | $10,032 | 5 |
| HIGH COST OF CAPITAL | $33.91 | 500 | 12.50% | 75.00% | 40.00% | $85,000 | $10,032 | 5 |
| LOW COST OF CAPITAL | $33.03 | 500 | 7.50% | 75.00% | 40.00% | $85,000 | $10,032 | 5 |
| LOW % UTILIZATION | $28.41 | 500 | 10.00% | 75.00% | 30.00% | $85,000 | $10,032 | 5 |
| HIGH % UTILIZATION | $38.61 | 500 | 10.00% | 75.00% | 50.00% | $85,000 | $10,032 | 5 |
| HIGH % CAP. BORROWED | $31.89 | 500 | 10.00% | 93.75% | 40.00% | $85,000 | $10,032 | 5 |
| HIGH EQUIP. PRICE | $38.18 | 500 | 10.00% | 75.00% | 40.00% | $106,250 | $10,032 | 5 |
| LOW EQUIP. PRICE | $28.76 | 500 | 10.00% | 75.00% | 40.00% | $63,750 | $10,032 | 5 |
| HIGH OP. EXPENSES | $38.48 | 500 | 10.00% | 75.00% | 40.00% | $85,000 | $12,540 | 5 |
| LOW OP. EXPENSES | $28.45 | 500 | 10.00% | 75.00% | 40.00% | $85,000 | $7,524 | 5 |
| LONG USEFUL LIFE | $32.19 | 500 | 10.00% | 75.00% | 40.00% | $85,000 | $7,524 | 6 |
| SHORT USEFUL LIFE | $33.99 | 500 | 10.00% | 75.00% | 40.00% | $85,000 | $7,524 | 4 |

Table 16a
SENSITIVITY ANALYSIS : EKG
Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $8.17 | 425 | 10.00% | 50.00% | 100.00% | $4,000 | $2,957 | 12 |
| HIGH ANN. PROCEDURES | $7.79 | 531.25 | 10.00% | 50.00% | 100.00% | $4,000 | $2,957 | 12 |
| LOW ANN. PROCEDURES | $8.81 | 318.75 | 10.00% | 50.00% | 100.00% | $4,000 | $2,957 | 12 |
| HIGH COST OF CAPITAL | $8.32 | 425 | 12.50% | 50.00% | 100.00% | $4,000 | $2,957 | 12 |
| LOW COST OF CAPITAL | $8.03 | 425 | 7.50% | 50.00% | 100.00% | $4,000 | $2,957 | 12 |
| LOW % UTILIZATION | $7.68 | 425 | 10.00% | 50.00% | 75.00% | $4,000 | $2,957 | 12 |
| HIGH % UTILIZATION | $8.17 | 425 | 10.00% | 50.00% | 100.00% | $4,000 | $2,957 | 12 |
| HIGH % CAP. BORROWED | $8.11 | 425 | 10.00% | 62.50% | 100.00% | $4,000 | $2,957 | 12 |
| HIGH EQUIP. PRICE | $8.59 | 425 | 10.00% | 50.00% | 100.00% | $5,000 | $2,957 | 12 |
| LOW EQUIP. PRICE | $7.76 | 425 | 10.00% | 50.00% | 100.00% | $3,000 | $2,957 | 12 |
| HIGH OP. EXPENSES | $9.92 | 425 | 10.00% | 50.00% | 100.00% | $4,000 | $3,697 | 12 |
| LOW OP. EXPENSES | $6.43 | 425 | 10.00% | 50.00% | 100.00% | $4,000 | $2,218 | 12 |
| LONG USEFUL LIFE | $8.17 | 425 | 10.00% | 50.00% | 100.00% | $4,000 | $2,957 | 12 |
| SHORT USEFUL LIFE | $8.37 | 425 | 10.00% | 50.00% | 100.00% | $4,000 | $2,957 | 9 |

Table 16b

SENSITIVITY ANALYSIS : EKG

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $13.92 | 700 | 10.00% | 0.00% | 100.00% | $13,000 | $7,142 | 8 |
| HIGH ANN. PROCEDURES | $12.78 | 875 | 10.00% | 0.00% | 100.00% | $13,000 | $7,142 | 8 |
| LOW ANN. PROCEDURES | $15.82 | 525 | 10.00% | 0.00% | 100.00% | $13,000 | $7,142 | 8 |
| HIGH COST OF CAPITAL | $14.38 | 700 | 12.50% | 0.00% | 100.00% | $13,000 | $7,142 | 8 |
| LOW COST OF CAPITAL | $13.48 | 700 | 7.50% | 0.00% | 100.00% | $13,000 | $7,142 | 8 |
| LOW % UTILIZATION | $12.49 | 700 | 10.00% | 0.00% | 75.00% | $13,000 | $7,142 | 8 |
| HIGH % UTILIZATION | $13.92 | 700 | 10.00% | 0.00% | 100.00% | $13,000 | $7,142 | 8 |
| HIGH % CAP. BORROWED | $13.57 | 700 | 10.00% | 25.00% | 100.00% | $13,000 | $7,142 | 8 |
| HIGH EQUIP. PRICE | $15.31 | 700 | 10.00% | 0.00% | 100.00% | $16,250 | $7,142 | 8 |
| LOW EQUIP. PRICE | $12.52 | 700 | 10.00% | 0.00% | 100.00% | $9,750 | $7,142 | 8 |
| HIGH OP. EXPENSES | $16.47 | 700 | 10.00% | 0.00% | 100.00% | $13,000 | $8,927 | 8 |
| LOW OP. EXPENSES | $11.36 | 700 | 10.00% | 0.00% | 100.00% | $13,000 | $5,356 | 8 |
| LONG USEFUL LIFE | $13.41 | 700 | 10.00% | 0.00% | 100.00% | $13,000 | $7,142 | 10 |
| SHORT USEFUL LIFE | $14.76 | 700 | 10.00% | 0.00% | 100.00% | $13,000 | $7,142 | 6 |

Table 17a

SENSITIVITY ANALYSIS: PERIPH. VASCULAR

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $10.62 | 300 | 10.00% | 0.00% | 60.00% | $5,000 | $2,316 | 5 |
| HIGH ANN. PROCEDURES | $9.95 | 375 | 10.00% | 0.00% | 60.00% | $5,000 | $2,316 | 5 |
| LOW ANN. PROCEDURES | $11.73 | 225 | 10.00% | 0.00% | 60.00% | $5,000 | $2,316 | 5 |
| HIGH COST OF CAPITAL | $10.88 | 300 | 12.50% | 0.00% | 60.00% | $5,000 | $2,316 | 5 |
| LOW COST OF CAPITAL | $10.36 | 300 | 7.50% | 0.00% | 60.00% | $5,000 | $2,316 | 5 |
| LOW % UTILIZATION | $9.78 | 300 | 10.00% | 0.00% | 45.00% | $5,000 | $2,316 | 5 |
| HIGH % UTILIZATION | $11.45 | 300 | 10.00% | 0.00% | 75.00% | $5,000 | $2,316 | 5 |
| HIGH % CAP. BORROWED | $10.32 | 300 | 10.00% | 25.00% | 60.00% | $5,000 | $2,316 | 5 |
| HIGH EQUIP. PRICE | $11.43 | 300 | 10.00% | 0.00% | 60.00% | $6,250 | $2,316 | 5 |
| LOW EQUIP. PRICE | $9.80 | 300 | 10.00% | 0.00% | 60.00% | $3,750 | $2,316 | 5 |
| HIGH OP. EXPENSES | $12.55 | 300 | 10.00% | 0.00% | 60.00% | $5,000 | $2,895 | 5 |
| LOW OP. EXPENSES | $8.69 | 300 | 10.00% | 0.00% | 60.00% | $5,000 | $1,737 | 5 |
| LONG USEFUL LIFE | $10.31 | 300 | 10.00% | 0.00% | 60.00% | $5,000 | $1,737 | 6 |
| SHORT USEFUL LIFE | $10.69 | 300 | 10.00% | 0.00% | 60.00% | $5,000 | $1,737 | 4 |

Table 17b

SENSITIVITY ANALYSIS: PERIPH. VASCULAR

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $25.97 | 500 | 10.00% | 75.00% | 30.00% | $90,000 | $7,729 | 5 |
| HIGH ANN. PROCEDURES | $22.98 | 625 | 10.00% | 75.00% | 30.00% | $90,000 | $7,729 | 5 |
| LOW ANN. PROCEDURES | $30.95 | 375 | 10.00% | 75.00% | 30.00% | $90,000 | $7,729 | 5 |
| HIGH COST OF CAPITAL | $26.32 | 500 | 12.50% | 75.00% | 30.00% | $90,000 | $7,729 | 5 |
| LOW COST OF CAPITAL | $25.62 | 500 | 7.50% | 75.00% | 30.00% | $90,000 | $7,729 | 5 |
| LOW % UTILIZATION | $22.16 | 500 | 10.00% | 75.00% | 22.50% | $90,000 | $7,729 | 5 |
| HIGH % UTILIZATION | $29.83 | 500 | 10.00% | 75.00% | 37.50% | $90,000 | $7,729 | 5 |
| HIGH % CAP. BORROWED | $24.69 | 500 | 10.00% | 93.75% | 30.00% | $90,000 | $7,729 | 5 |
| HIGH EQUIP. PRICE | $29.54 | 500 | 10.00% | 75.00% | 30.00% | $112,500 | $7,729 | 5 |
| LOW EQUIP. PRICE | $22.40 | 500 | 10.00% | 75.00% | 30.00% | $67,500 | $7,729 | 5 |
| HIGH OP. EXPENSES | $29.83 | 500 | 10.00% | 75.00% | 30.00% | $90,000 | $9,661 | 5 |
| LOW OP. EXPENSES | $22.10 | 500 | 10.00% | 75.00% | 30.00% | $90,000 | $5,797 | 5 |
| LONG USEFUL LIFE | $24.97 | 500 | 10.00% | 75.00% | 30.00% | $90,000 | $5,797 | 6 |
| SHORT USEFUL LIFE | $26.39 | 500 | 10.00% | 75.00% | 30.00% | $90,000 | $5,797 | 4 |

Table 18a

SENSITIVITY ANALYSIS: CHEST X-RAY, 1

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $13.72 | 142 | 10.00% | 75.00% | 10.00% | $50,000 | $1,481 | 10 |
| HIGH ANN. PROCEDURES | $12.42 | 177.5 | 10.00% | 75.00% | 10.00% | $50,000 | $1,481 | 10 |
| LOW ANN. PROCEDURES | $15.89 | 106.5 | 10.00% | 75.00% | 10.00% | $50,000 | $1,481 | 10 |
| HIGH COST OF CAPITAL | $13.87 | 142 | 12.50% | 75.00% | 10.00% | $50,000 | $1,481 | 10 |
| LOW COST OF CAPITAL | $13.58 | 142 | 7.50% | 75.00% | 10.00% | $50,000 | $1,481 | 10 |
| LOW % UTILIZATION | $12.09 | 142 | 10.00% | 75.00% | 7.50% | $50,000 | $1,481 | 10 |
| HIGH % UTILIZATION | $15.36 | 142 | 10.00% | 75.00% | 12.50% | $50,000 | $1,481 | 10 |
| HIGH % CAP. BORROWED | $13.26 | 142 | 10.00% | 93.75% | 10.00% | $50,000 | $1,481 | 10 |
| HIGH EQUIP. PRICE | $14.99 | 142 | 10.00% | 75.00% | 10.00% | $62,500 | $1,481 | 10 |
| LOW EQUIP. PRICE | $12.46 | 142 | 10.00% | 75.00% | 10.00% | $37,500 | $1,481 | 10 |
| HIGH OP. EXPENSES | $16.33 | 142 | 10.00% | 75.00% | 10.00% | $50,000 | $1,851 | 10 |
| LOW OP. EXPENSES | $11.12 | 142 | 10.00% | 75.00% | 10.00% | $50,000 | $1,111 | 10 |
| LONG USEFUL LIFE | $10.90 | 142 | 10.00% | 75.00% | 10.00% | $50,000 | $1,111 | 13 |
| SHORT USEFUL LIFE | $13.23 | 142 | 10.00% | 75.00% | 10.00% | $50,000 | $1,111 | 9 |

Table 18b

SENSITIVITY ANALYSIS: CHEST X-RAY, 1

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $21.32 | 210 | 10.00% | 75.00% | 10.00% | $100,000 | $3,541 | 10 |
| HIGH ANN. PROCEDURES | $19.21 | 262.5 | 10.00% | 75.00% | 10.00% | $100,000 | $3,541 | 10 |
| LOW ANN. PROCEDURES | $24.82 | 157.5 | 10.00% | 75.00% | 10.00% | $100,000 | $3,541 | 10 |
| HIGH COST OF CAPITAL | $21.51 | 210 | 12.50% | 75.00% | 10.00% | $100,000 | $3,541 | 10 |
| LOW COST OF CAPITAL | $21.12 | 210 | 7.50% | 75.00% | 10.00% | $100,000 | $3,541 | 10 |
| LOW % UTILIZATION | $18.67 | 210 | 10.00% | 75.00% | 7.50% | $100,000 | $3,541 | 10 |
| HIGH % UTILIZATION | $23.97 | 210 | 10.00% | 75.00% | 12.50% | $100,000 | $3,541 | 10 |
| HIGH % CAP. BORROWED | $20.68 | 210 | 10.00% | 93.75% | 10.00% | $100,000 | $3,541 | 10 |
| HIGH EQUIP. PRICE | $23.62 | 210 | 10.00% | 75.00% | 10.00% | $125,000 | $3,541 | 10 |
| LOW EQUIP. PRICE | $19.01 | 210 | 10.00% | 75.00% | 10.00% | $75,000 | $3,541 | 10 |
| HIGH OP. EXPENSES | $25.53 | 210 | 10.00% | 75.00% | 10.00% | $100,000 | $4,426 | 10 |
| LOW OP. EXPENSES | $17.10 | 210 | 10.00% | 75.00% | 10.00% | $100,000 | $2,655 | 10 |
| LONG USEFUL LIFE | $16.81 | 210 | 10.00% | 75.00% | 10.00% | $100,000 | $2,655 | 12 |
| SHORT USEFUL LIFE | $19.97 | 210 | 10.00% | 75.00% | 10.00% | $100,000 | $2,655 | 8 |

Table 19a

SENSITIVITY ANALYSIS: CHEST X-RAY, 2

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $13.18 | 283 | 10.00% | 75.00% | 10.00% | $50,000 | $3,262 | 10 |
| HIGH ANN. PROCEDURES | $12.53 | 353.75 | 10.00% | 75.00% | 10.00% | $50,000 | $3,262 | 10 |
| LOW ANN. PROCEDURES | $14.27 | 212.25 | 10.00% | 75.00% | 10.00% | $50,000 | $3,262 | 10 |
| HIGH COST OF CAPITAL | $13.25 | 283 | 12.50% | 75.00% | 10.00% | $50,000 | $3,262 | 10 |
| LOW COST OF CAPITAL | $13.11 | 283 | 7.50% | 75.00% | 10.00% | $50,000 | $3,262 | 10 |
| LOW % UTILIZATION | $12.36 | 283 | 10.00% | 75.00% | 7.50% | $50,000 | $3,262 | 10 |
| HIGH % UTILIZATION | $14.00 | 283 | 10.00% | 75.00% | 12.50% | $50,000 | $3,262 | 10 |
| HIGH % CAP. BORROWED | $12.95 | 283 | 10.00% | 93.75% | 10.00% | $50,000 | $3,262 | 10 |
| HIGH EQUIP. PRICE | $13.82 | 283 | 10.00% | 75.00% | 10.00% | $62,500 | $3,262 | 10 |
| LOW EQUIP. PRICE | $12.55 | 283 | 10.00% | 75.00% | 10.00% | $37,500 | $3,262 | 10 |
| HIGH OP. EXPENSES | $16.06 | 283 | 10.00% | 75.00% | 10.00% | $50,000 | $4,078 | 10 |
| LOW OP. EXPENSES | $10.30 | 283 | 10.00% | 75.00% | 10.00% | $50,000 | $2,447 | 10 |
| LONG USEFUL LIFE | $10.19 | 283 | 10.00% | 75.00% | 10.00% | $50,000 | $2,447 | 13 |
| SHORT USEFUL LIFE | $11.36 | 283 | 10.00% | 75.00% | 10.00% | $50,000 | $2,447 | 8 |

Table 19b

SENSITIVITY ANALYSIS: CHEST X-RAY, 2

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $25.12 | 428 | 10.00% | 75.00% | 20.00% | $100,000 | $8,855 | 10 |
| HIGH ANN. PROCEDURES | $23.05 | 535 | 10.00% | 75.00% | 20.00% | $100,000 | $8,855 | 10 |
| LOW ANN. PROCEDURES | $28.59 | 321 | 10.00% | 75.00% | 20.00% | $100,000 | $8,855 | 10 |
| HIGH COST OF CAPITAL | $25.32 | 428 | 12.50% | 75.00% | 20.00% | $100,000 | $8,855 | 10 |
| LOW COST OF CAPITAL | $24.93 | 428 | 7.50% | 75.00% | 20.00% | $100,000 | $8,855 | 10 |
| LOW % UTILIZATION | $22.50 | 428 | 10.00% | 75.00% | 15.00% | $100,000 | $8,855 | 10 |
| HIGH % UTILIZATION | $27.76 | 428 | 10.00% | 75.00% | 25.00% | $100,000 | $8,855 | 10 |
| HIGH % CAP. BORROWED | $24.52 | 428 | 10.00% | 93.75% | 20.00% | $100,000 | $8,855 | 10 |
| HIGH EQUIP. PRICE | $27.40 | 428 | 10.00% | 75.00% | 20.00% | $125,000 | $8,855 | 10 |
| LOW EQUIP. PRICE | $22.85 | 428 | 10.00% | 75.00% | 20.00% | $75,000 | $8,855 | 10 |
| HIGH OP. EXPENSES | $30.30 | 428 | 10.00% | 75.00% | 20.00% | $100,000 | $11,069 | 10 |
| LOW OP. EXPENSES | $19.95 | 428 | 10.00% | 75.00% | 20.00% | $100,000 | $6,642 | 10 |
| LONG USEFUL LIFE | $19.66 | 428 | 10.00% | 75.00% | 20.00% | $100,000 | $6,642 | 13 |
| SHORT USEFUL LIFE | $22.79 | 428 | 10.00% | 75.00% | 20.00% | $100,000 | $6,642 | 8 |

Table 20a

SENSITIVITY ANALYSIS: PELVIS X-RAY

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $58.94 | 8 | 10.00% | 75.00% | 4.50% | $50,000 | $263 | 10 |
| HIGH ANN. PROCEDURES | $48.62 | 10 | 10.00% | 75.00% | 4.50% | $50,000 | $263 | 10 |
| LOW ANN. PROCEDURES | $76.18 | 6 | 10.00% | 75.00% | 4.50% | $50,000 | $263 | 10 |
| HIGH COST OF CAPITAL | $60.12 | 8 | 12.50% | 75.00% | 4.50% | $50,000 | $263 | 10 |
| LOW COST OF CAPITAL | $57.80 | 8 | 7.50% | 75.00% | 4.50% | $50,000 | $263 | 10 |
| LOW % UTILIZATION | $46.00 | 8 | 10.00% | 75.00% | 3.38% | $50,000 | $263 | 10 |
| HIGH % UTILIZATION | $71.93 | 8 | 10.00% | 75.00% | 5.62% | $50,000 | $263 | 10 |
| HIGH % CAP. BORROWED | $55.17 | 8 | 10.00% | 93.75% | 4.50% | $50,000 | $263 | 10 |
| HIGH EQUIP. PRICE | $68.98 | 8 | 10.00% | 75.00% | 4.50% | $62,500 | $263 | 10 |
| LOW EQUIP. PRICE | $48.92 | 8 | 10.00% | 75.00% | 4.50% | $37,500 | $263 | 10 |
| HIGH OP. EXPENSES | $67.15 | 8 | 10.00% | 75.00% | 4.50% | $50,000 | $328 | 10 |
| LOW OP. EXPENSES | $50.75 | 8 | 10.00% | 75.00% | 4.50% | $50,000 | $197 | 10 |
| LONG USEFUL LIFE | $49.09 | 8 | 10.00% | 75.00% | 4.50% | $50,000 | $197 | 13 |
| SHORT USEFUL LIFE | $67.56 | 8 | 10.00% | 75.00% | 4.50% | $50,000 | $197 | 8 |

Table 20b

SENSITIVITY ANALYSIS: PELVIS X-RAY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $26.19 | 71 | 10.00% | 75.00% | 4.50% | $100,000 | $1,442 | 10 |
| HIGH ANN. PROCEDURES | $23.40 | 88.75 | 10.00% | 75.00% | 4.50% | $100,000 | $1,442 | 10 |
| LOW ANN. PROCEDURES | $30.85 | 53.25 | 10.00% | 75.00% | 4.50% | $100,000 | $1,442 | 10 |
| HIGH COST OF CAPITAL | $26.46 | 71 | 12.50% | 75.00% | 4.50% | $100,000 | $1,442 | 10 |
| LOW COST OF CAPITAL | $25.94 | 71 | 7.50% | 75.00% | 4.50% | $100,000 | $1,442 | 10 |
| LOW % UTILIZATION | $22.70 | 71 | 10.00% | 75.00% | 3.38% | $100,000 | $1,442 | 10 |
| HIGH % UTILIZATION | $29.70 | 71 | 10.00% | 75.00% | 5.62% | $100,000 | $1,442 | 10 |
| HIGH % CAP. BORROWED | $25.34 | 71 | 10.00% | 93.75% | 4.50% | $100,000 | $1,442 | 10 |
| HIGH EQUIP. PRICE | $29.25 | 71 | 10.00% | 75.00% | 4.50% | $125,000 | $1,442 | 10 |
| LOW EQUIP. PRICE | $23.14 | 71 | 10.00% | 75.00% | 4.50% | $75,000 | $1,442 | 10 |
| HIGH OP. EXPENSES | $31.27 | 71 | 10.00% | 75.00% | 4.50% | $100,000 | $1,803 | 10 |
| LOW OP. EXPENSES | $21.12 | 71 | 10.00% | 75.00% | 4.50% | $100,000 | $1,082 | 10 |
| LONG USEFUL LIFE | $20.74 | 71 | 10.00% | 75.00% | 4.50% | $100,000 | $1,082 | 13 |
| SHORT USEFUL LIFE | $24.91 | 71 | 10.00% | 75.00% | 4.50% | $100,000 | $1,082 | 8 |

Table 21a

SENSITIVITY ANALYSIS: HIP X-RAY

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $65.88 | 25 | 10.00% | 75.00% | 15.10% | $50,000 | $936 | 10 |
| HIGH ANN. PROCEDURES | $54.70 | 31.25 | 10.00% | 75.00% | 15.10% | $50,000 | $936 | 10 |
| LOW ANN. PROCEDURES | $84.54 | 18.75 | 10.00% | 75.00% | 15.10% | $50,000 | $936 | 10 |
| HIGH COST OF CAPITAL | $67.14 | 25 | 12.50% | 75.00% | 15.10% | $50,000 | $936 | 10 |
| LOW COST OF CAPITAL | $64.64 | 25 | 7.50% | 75.00% | 15.10% | $50,000 | $936 | 10 |
| LOW % UTILIZATION | $51.79 | 25 | 10.00% | 75.00% | 11.32% | $50,000 | $936 | 10 |
| HIGH % UTILIZATION | $80.07 | 25 | 10.00% | 75.00% | 18.88% | $50,000 | $936 | 10 |
| HIGH % CAP. BORROWED | $61.92 | 25 | 10.00% | 93.75% | 15.10% | $50,000 | $936 | 10 |
| HIGH EQUIP. PRICE | $76.78 | 25 | 10.00% | 75.00% | 15.10% | $62,500 | $936 | 10 |
| LOW EQUIP. PRICE | $55.00 | 25 | 10.00% | 75.00% | 15.10% | $37,500 | $936 | 10 |
| HIGH OP. EXPENSES | $75.24 | 25 | 10.00% | 75.00% | 15.10% | $50,000 | $1,170 | 10 |
| LOW OP. EXPENSES | $56.53 | 25 | 10.00% | 75.00% | 15.10% | $50,000 | $702 | 10 |
| LONG USEFUL LIFE | $54.68 | 25 | 10.00% | 75.00% | 15.10% | $50,000 | $702 | 13 |
| SHORT USEFUL LIFE | $74.80 | 25 | 10.00% | 75.00% | 15.10% | $50,000 | $702 | 8 |

Table 21b

SENSITIVITY ANALYSIS: HIP X-RAY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $28.98 | 235 | 10.00% | 75.00% | 15.10% | $100,000 | $5,388 | 10 |
| HIGH ANN. PROCEDURES | $26.13 | 293.75 | 10.00% | 75.00% | 15.10% | $100,000 | $5,388 | 10 |
| LOW ANN. PROCEDURES | $33.73 | 176.25 | 10.00% | 75.00% | 15.10% | $100,000 | $5,388 | 10 |
| HIGH COST OF CAPITAL | $29.25 | 235 | 12.50% | 75.00% | 15.10% | $100,000 | $5,388 | 10 |
| LOW COST OF CAPITAL | $28.72 | 235 | 7.50% | 75.00% | 15.10% | $100,000 | $5,388 | 10 |
| LOW % UTILIZATION | $25.40 | 235 | 10.00% | 75.00% | 11.32% | $100,000 | $5,388 | 10 |
| HIGH % UTILIZATION | $32.58 | 235 | 10.00% | 75.00% | 18.88% | $100,000 | $5,388 | 10 |
| HIGH % CAP. BORROWED | $28.14 | 235 | 10.00% | 93.75% | 15.10% | $100,000 | $5,388 | 10 |
| HIGH EQUIP. PRICE | $32.10 | 235 | 10.00% | 75.00% | 15.10% | $125,000 | $5,388 | 10 |
| LOW EQUIP. PRICE | $25.86 | 235 | 10.00% | 75.00% | 15.10% | $75,000 | $5,388 | 10 |
| HIGH OP. EXPENSES | $34.71 | 235 | 10.00% | 75.00% | 15.10% | $100,000 | $6,735 | 10 |
| LOW OP. EXPENSES | $23.25 | 235 | 10.00% | 75.00% | 15.10% | $100,000 | $4,041 | 10 |
| LONG USEFUL LIFE | $22.86 | 235 | 10.00% | 75.00% | 15.10% | $100,000 | $4,041 | 13 |
| SHORT USEFUL LIFE | $27.14 | 235 | 10.00% | 75.00% | 15.10% | $100,000 | $4,041 | 8 |

Table 22a

SENSITIVITY ANALYSIS: SHOULDER X-RAY

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $64.16 | 11 | 10.00% | 75.00% | 6.80% | $50,000 | $389 | 10 |
| HIGH ANN. PROCEDURES | $52.78 | 13.75 | 10.00% | 75.00% | 6.80% | $50,000 | $389 | 10 |
| LOW ANN. PROCEDURES | $83.14 | 8.25 | 10.00% | 75.00% | 6.80% | $50,000 | $389 | 10 |
| HIGH COST OF CAPITAL | $65.45 | 11 | 12.50% | 75.00% | 6.80% | $50,000 | $389 | 10 |
| LOW COST OF CAPITAL | $62.90 | 11 | 7.50% | 75.00% | 6.80% | $50,000 | $389 | 10 |
| LOW % UTILIZATION | $49.88 | 11 | 10.00% | 75.00% | 5.10% | $50,000 | $389 | 10 |
| HIGH % UTILIZATION | $78.49 | 11 | 10.00% | 75.00% | 8.50% | $50,000 | $389 | 10 |
| HIGH % CAP. BORROWED | $60.03 | 11 | 10.00% | 93.75% | 6.80% | $50,000 | $389 | 10 |
| HIGH EQUIP. PRICE | $75.22 | 11 | 10.00% | 75.00% | 6.80% | $62,500 | $389 | 10 |
| LOW EQUIP. PRICE | $53.12 | 11 | 10.00% | 75.00% | 6.80% | $37,500 | $389 | 10 |
| HIGH OP. EXPENSES | $73.01 | 11 | 10.00% | 75.00% | 6.80% | $50,000 | $486 | 10 |
| LOW OP. EXPENSES | $55.33 | 11 | 10.00% | 75.00% | 6.80% | $50,000 | $292 | 10 |
| LONG USEFUL LIFE | $53.49 | 11 | 10.00% | 75.00% | 6.80% | $50,000 | $292 | 13 |
| SHORT USEFUL LIFE | $73.85 | 11 | 10.00% | 75.00% | 6.80% | $50,000 | $292 | 8 |

Table 22b

SENSITIVITY ANALYSIS: SHOULDER X-RAY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $24.94 | 106 | 10.00% | 75.00% | 6.80% | $100,000 | $2,010 | 10 |
| HIGH ANN. PROCEDURES | $22.11 | 132.5 | 10.00% | 75.00% | 6.80% | $100,000 | $2,010 | 10 |
| LOW ANN. PROCEDURES | $29.66 | 79.5 | 10.00% | 75.00% | 6.80% | $100,000 | $2,010 | 10 |
| HIGH COST OF CAPITAL | $25.21 | 106 | 12.50% | 75.00% | 6.80% | $100,000 | $2,010 | 10 |
| LOW COST OF CAPITAL | $24.68 | 106 | 7.50% | 75.00% | 6.80% | $100,000 | $2,010 | 10 |
| LOW % UTILIZATION | $21.39 | 106 | 10.00% | 75.00% | 5.10% | $100,000 | $2,010 | 10 |
| HIGH % UTILIZATION | $28.49 | 106 | 10.00% | 75.00% | 8.50% | $100,000 | $2,010 | 10 |
| HIGH % CAP. BORROWED | $24.08 | 106 | 10.00% | 93.75% | 6.80% | $100,000 | $2,010 | 10 |
| HIGH EQUIP. PRICE | $28.04 | 106 | 10.00% | 75.00% | 6.80% | $125,000 | $2,010 | 10 |
| LOW EQUIP. PRICE | $21.84 | 106 | 10.00% | 75.00% | 6.80% | $75,000 | $2,010 | 10 |
| HIGH OP. EXPENSES | $29.68 | 106 | 10.00% | 75.00% | 6.80% | $100,000 | $2,513 | 10 |
| LOW OP. EXPENSES | $20.20 | 106 | 10.00% | 75.00% | 6.80% | $100,000 | $1,508 | 10 |
| LONG USEFUL LIFE | $19.82 | 106 | 10.00% | 75.00% | 6.80% | $100,000 | $1,508 | 13 |
| SHORT USEFUL LIFE | $24.05 | 106 | 10.00% | 75.00% | 6.80% | $100,000 | $1,508 | 8 |

Table 23a

SENSITIVITY ANALYSIS: KNEE X-RAY

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $64.17 | 22 | 10.00% | 75.00% | 12.90% | $50,000 | $806 | 10 |
| HIGH ANN. PROCEDURES | $53.32 | 27.5 | 10.00% | 75.00% | 12.90% | $50,000 | $806 | 10 |
| LOW ANN. PROCEDURES | $82.25 | 16.5 | 10.00% | 75.00% | 12.90% | $50,000 | $806 | 10 |
| HIGH COST OF CAPITAL | $65.39 | 22 | 12.50% | 75.00% | 12.90% | $50,000 | $806 | 10 |
| LOW COST OF CAPITAL | $62.96 | 22 | 7.50% | 75.00% | 12.90% | $50,000 | $806 | 10 |
| LOW % UTILIZATION | $50.52 | 22 | 10.00% | 75.00% | 9.68% | $50,000 | $806 | 10 |
| HIGH % UTILIZATION | $77.89 | 22 | 10.00% | 75.00% | 16.13% | $50,000 | $806 | 10 |
| HIGH % CAP. BORROWED | $60.30 | 22 | 10.00% | 93.75% | 12.90% | $50,000 | $806 | 10 |
| HIGH EQUIP. PRICE | $74.72 | 22 | 10.00% | 75.00% | 12.90% | $62,500 | $806 | 10 |
| LOW EQUIP. PRICE | $53.62 | 22 | 10.00% | 75.00% | 12.90% | $37,500 | $806 | 10 |
| HIGH OP. EXPENSES | $73.32 | 22 | 10.00% | 75.00% | 12.90% | $50,000 | $1,007 | 10 |
| LOW OP. EXPENSES | $55.02 | 22 | 10.00% | 75.00% | 12.90% | $50,000 | $604 | 10 |
| LONG USEFUL LIFE | $53.23 | 22 | 10.00% | 75.00% | 12.90% | $50,000 | $604 | 13 |
| SHORT USEFUL LIFE | $72.71 | 22 | 10.00% | 75.00% | 12.90% | $50,000 | $604 | 8 |

Table 23b

SENSITIVITY ANALYSIS: KNEE X-RAY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $29.01 | 200 | 10.00% | 75.00% | 12.90% | $100,000 | $4,591 | 10 |
| HIGH ANN. PROCEDURES | $26.16 | 250 | 10.00% | 75.00% | 12.90% | $100,000 | $4,591 | 10 |
| LOW ANN. PROCEDURES | $33.77 | 150 | 10.00% | 75.00% | 12.90% | $100,000 | $4,591 | 10 |
| HIGH COST OF CAPITAL | $29.28 | 200 | 12.50% | 75.00% | 12.90% | $100,000 | $4,591 | 10 |
| LOW COST OF CAPITAL | $28.75 | 200 | 7.50% | 75.00% | 12.90% | $100,000 | $4,591 | 10 |
| LOW % UTILIZATION | $25.42 | 200 | 10.00% | 75.00% | 9.68% | $100,000 | $4,591 | 10 |
| HIGH % UTILIZATION | $32.62 | 200 | 10.00% | 75.00% | 16.13% | $100,000 | $4,591 | 10 |
| HIGH % CAP. BORROWED | $28.16 | 200 | 10.00% | 93.75% | 12.90% | $100,000 | $4,591 | 10 |
| HIGH EQUIP. PRICE | $32.14 | 200 | 10.00% | 75.00% | 12.90% | $125,000 | $4,591 | 10 |
| LOW EQUIP. PRICE | $25.89 | 200 | 10.00% | 75.00% | 12.90% | $75,000 | $4,591 | 10 |
| HIGH OP. EXPENSES | $34.75 | 200 | 10.00% | 75.00% | 12.90% | $100,000 | $5,739 | 10 |
| LOW OP. EXPENSES | $23.28 | 200 | 10.00% | 75.00% | 12.90% | $100,000 | $3,443 | 10 |
| LONG USEFUL LIFE | $22.88 | 200 | 10.00% | 75.00% | 12.90% | $100,000 | $3,443 | 13 |
| SHORT USEFUL LIFE | $27.17 | 200 | 10.00% | 75.00% | 12.90% | $100,000 | $3,443 | 8 |

Table 24a

SENSITIVITY ANALYSIS: FOOT X-RAY

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $64.83 | 18 | 10.00% | 75.00% | 10.70% | $50,000 | $666 | 10 |
| HIGH ANN. PROCEDURES | $53.85 | 22.5 | 10.00% | 75.00% | 10.70% | $50,000 | $666 | 10 |
| LOW ANN. PROCEDURES | $83.13 | 13.5 | 10.00% | 75.00% | 10.70% | $50,000 | $666 | 10 |
| HIGH COST OF CAPITAL | $66.06 | 18 | 12.50% | 75.00% | 10.70% | $50,000 | $666 | 10 |
| LOW COST OF CAPITAL | $63.60 | 18 | 7.50% | 75.00% | 10.70% | $50,000 | $666 | 10 |
| LOW % UTILIZATION | $51.03 | 18 | 10.00% | 75.00% | 8.03% | $50,000 | $666 | 10 |
| HIGH % UTILIZATION | $78.69 | 18 | 10.00% | 75.00% | 13.38% | $50,000 | $666 | 10 |
| HIGH % CAP. BORROWED | $60.88 | 18 | 10.00% | 93.75% | 10.70% | $50,000 | $666 | 10 |
| HIGH EQUIP. PRICE | $75.50 | 18 | 10.00% | 75.00% | 10.70% | $62,500 | $666 | 10 |
| LOW EQUIP. PRICE | $54.16 | 18 | 10.00% | 75.00% | 10.70% | $37,500 | $666 | 10 |
| HIGH OP. EXPENSES | $74.08 | 18 | 10.00% | 75.00% | 10.70% | $50,000 | $832 | 10 |
| LOW OP. EXPENSES | $55.58 | 18 | 10.00% | 75.00% | 10.70% | $50,000 | $499 | 10 |
| LONG USEFUL LIFE | $53.79 | 18 | 10.00% | 75.00% | 10.70% | $50,000 | $499 | 13 |
| SHORT USEFUL LIFE | $73.48 | 18 | 10.00% | 75.00% | 10.70% | $50,000 | $499 | 8 |

Table 24b

SENSITIVITY ANALYSIS: FOOT X-RAY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $28.99 | 166 | 10.00% | 75.00% | 10.70% | $100,000 | $3,809 | 10 |
| HIGH ANN. PROCEDURES | $26.14 | 207.5 | 10.00% | 75.00% | 10.70% | $100,000 | $3,809 | 10 |
| LOW ANN. PROCEDURES | $33.73 | 124.5 | 10.00% | 75.00% | 10.70% | $100,000 | $3,809 | 10 |
| HIGH COST OF CAPITAL | $29.25 | 166 | 12.50% | 75.00% | 10.70% | $100,000 | $3,809 | 10 |
| LOW COST OF CAPITAL | $28.72 | 166 | 7.50% | 75.00% | 10.70% | $100,000 | $3,809 | 10 |
| LOW % UTILIZATION | $25.41 | 166 | 10.00% | 75.00% | 8.03% | $100,000 | $3,809 | 10 |
| HIGH % UTILIZATION | $32.58 | 166 | 10.00% | 75.00% | 13.38% | $100,000 | $3,809 | 10 |
| HIGH % CAP. BORROWED | $28.13 | 166 | 10.00% | 93.75% | 10.70% | $100,000 | $3,809 | 10 |
| HIGH EQUIP. PRICE | $32.11 | 166 | 10.00% | 75.00% | 10.70% | $125,000 | $3,809 | 10 |
| LOW EQUIP. PRICE | $25.86 | 166 | 10.00% | 75.00% | 10.70% | $75,000 | $3,809 | 10 |
| HIGH OP. EXPENSES | $34.72 | 166 | 10.00% | 75.00% | 10.70% | $100,000 | $4,762 | 10 |
| LOW OP. EXPENSES | $23.25 | 166 | 10.00% | 75.00% | 10.70% | $100,000 | $2,857 | 10 |
| LONG USEFUL LIFE | $22.86 | 166 | 10.00% | 75.00% | 10.70% | $100,000 | $2,857 | 13 |
| SHORT USEFUL LIFE | $27.13 | 166 | 10.00% | 75.00% | 10.70% | $100,000 | $2,857 | 8 |

Table 25a

SENSITIVITY ANALYSIS: UPPER G.I. X-RAY

Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $57.21 | 333 | 10.00% | 75.00% | 50.00% | $150,000 | $11,639 | 10 |
| HIGH ANN. PROCEDURES | $49.77 | 416.25 | 10.00% | 75.00% | 50.00% | $150,000 | $11,639 | 10 |
| LOW ANN. PROCEDURES | $69.61 | 249.75 | 10.00% | 75.00% | 50.00% | $150,000 | $11,639 | 10 |
| HIGH COST OF CAPITAL | $58.16 | 333 | 12.50% | 75.00% | 50.00% | $150,000 | $11,639 | 10 |
| LOW COST OF CAPITAL | $56.26 | 333 | 7.50% | 75.00% | 50.00% | $150,000 | $11,639 | 10 |
| LOW % UTILIZATION | $47.63 | 333 | 10.00% | 75.00% | 37.50% | $150,000 | $11,639 | 10 |
| HIGH % UTILIZATION | $66.97 | 333 | 10.00% | 75.00% | 62.50% | $150,000 | $11,639 | 10 |
| HIGH % CAP. BORROWED | $54.51 | 333 | 10.00% | 93.75% | 50.00% | $150,000 | $11,639 | 10 |
| HIGH EQUIP. PRICE | $65.03 | 333 | 10.00% | 75.00% | 50.00% | $187,500 | $11,639 | 10 |
| LOW EQUIP. PRICE | $49.39 | 333 | 10.00% | 75.00% | 50.00% | $112,500 | $11,639 | 10 |
| HIGH OP. EXPENSES | $65.95 | 333 | 10.00% | 75.00% | 50.00% | $150,000 | $14,549 | 10 |
| LOW OP. EXPENSES | $48.47 | 333 | 10.00% | 75.00% | 50.00% | $150,000 | $8,730 | 10 |
| LONG USEFUL LIFE | $55.65 | 333 | 10.00% | 75.00% | 50.00% | $150,000 | $8,730 | 13 |
| SHORT USEFUL LIFE | $71.31 | 333 | 10.00% | 75.00% | 50.00% | $150,000 | $8,730 | 8 |

Table 25b

SENSITIVITY ANALYSIS: UPPER G.I. X-RAY

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $82.64 | 333 | 10.00% | 75.00% | 50.00% | $200,000 | $17,638 | 10 |
| HIGH ANN. PROCEDURES | $70.72 | 416.25 | 10.00% | 75.00% | 50.00% | $200,000 | $17,638 | 10 |
| LOW ANN. PROCEDURES | $102.52 | 249.75 | 10.00% | 75.00% | 50.00% | $200,000 | $17,638 | 10 |
| HIGH COST OF CAPITAL | $83.91 | 333 | 12.50% | 75.00% | 50.00% | $200,000 | $17,638 | 10 |
| LOW COST OF CAPITAL | $81.37 | 333 | 7.50% | 75.00% | 50.00% | $200,000 | $17,638 | 10 |
| LOW % UTILIZATION | $67.37 | 333 | 10.00% | 75.00% | 37.50% | $200,000 | $17,638 | 10 |
| HIGH % UTILIZATION | $98.17 | 333 | 10.00% | 75.00% | 62.50% | $200,000 | $17,638 | 10 |
| HIGH % CAP. BORROWED | $79.04 | 333 | 10.00% | 93.75% | 50.00% | $200,000 | $17,638 | 10 |
| HIGH EQUIP. PRICE | $96.07 | 333 | 10.00% | 75.00% | 50.00% | $250,000 | $17,638 | 10 |
| LOW EQUIP. PRICE | $69.22 | 333 | 10.00% | 75.00% | 50.00% | $150,000 | $17,638 | 10 |
| HIGH OP. EXPENSES | $95.88 | 333 | 10.00% | 75.00% | 50.00% | $200,000 | $22,048 | 10 |
| LOW OP. EXPENSES | $69.40 | 333 | 10.00% | 75.00% | 50.00% | $200,000 | $13,229 | 10 |
| LONG USEFUL LIFE | $80.57 | 333 | 10.00% | 75.00% | 50.00% | $200,000 | $13,229 | 13 |
| SHORT USEFUL LIFE | $101.45 | 333 | 10.00% | 75.00% | 50.00% | $200,000 | $13,229 | 8 |

Table 26a

SENSITIVITY ANALYSIS: C.T. Scan

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $129.00 | 1560 | 10.00% | 75.00% | 60.00% | $500,000 | $155,399 | 7 |
| HIGH ANN. PROCEDURES | $119.61 | 1950 | 10.00% | 75.00% | 60.00% | $500,000 | $155,399 | 7 |
| LOW ANN. PROCEDURES | $144.66 | 1170 | 10.00% | 75.00% | 60.00% | $500,000 | $155,399 | 7 |
| HIGH COST OF CAPITAL | $130.65 | 1560 | 12.50% | 75.00% | 60.00% | $500,000 | $155,399 | 7 |
| LOW COST OF CAPITAL | $127.36 | 1560 | 7.50% | 75.00% | 60.00% | $500,000 | $155,399 | 7 |
| LOW % UTILIZATION | $116.84 | 1560 | 10.00% | 75.00% | 45.00% | $500,000 | $155,399 | 7 |
| HIGH % UTILIZATION | $141.44 | 1560 | 10.00% | 75.00% | 75.00% | $500,000 | $155,399 | 7 |
| HIGH % CAP. BORROWED | $125.72 | 1560 | 10.00% | 93.75% | 60.00% | $500,000 | $155,399 | 7 |
| HIGH EQUIP. PRICE | $139.96 | 1560 | 10.00% | 75.00% | 60.00% | $625,000 | $155,399 | 7 |
| LOW EQUIP. PRICE | $118.05 | 1560 | 10.00% | 75.00% | 60.00% | $375,000 | $155,399 | 7 |
| HIGH OP. EXPENSES | $153.91 | 1560 | 10.00% | 75.00% | 60.00% | $500,000 | $194,249 | 7 |
| LOW OP. EXPENSES | $104.10 | 1560 | 10.00% | 75.00% | 60.00% | $500,000 | $116,549 | 7 |
| LONG USEFUL LIFE | $128.03 | 1560 | 10.00% | 75.00% | 60.00% | $500,000 | $116,549 | 9 |
| SHORT USEFUL LIFE | $139.96 | 1560 | 10.00% | 75.00% | 60.00% | $500,000 | $116,549 | 5 |

Table 26b

SENSITIVITY ANALYSIS: C.T. Scan

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $223.772 | 1000 | 10.00% | 75.00% | 60.00% | $800,000 | $187,453 | 7 |
| HIGH ANN. PROCEDURES | $198.423 | 1250 | 10.00% | 75.00% | 60.00% | $800,000 | $187,453 | 7 |
| LOW ANN. PROCEDURES | $266.019 | 750 | 10.00% | 75.00% | 60.00% | $800,000 | $187,453 | 7 |
| HIGH COST OF CAPITAL | $228.156 | 1000 | 12.50% | 75.00% | 60.00% | $800,000 | $187,453 | 7 |
| LOW COST OF CAPITAL | $219.412 | 1000 | 7.50% | 75.00% | 60.00% | $800,000 | $187,453 | 7 |
| LOW % UTILIZATION | $191.753 | 1000 | 10.00% | 75.00% | 45.00% | $800,000 | $187,453 | 7 |
| HIGH % UTILIZATION | $256.013 | 1000 | 10.00% | 75.00% | 75.00% | $800,000 | $187,453 | 7 |
| HIGH % CAP. BORROWED | $215.837 | 1000 | 10.00% | 93.75% | 60.00% | $800,000 | $187,453 | 7 |
| HIGH EQUIP. PRICE | $254.224 | 1000 | 10.00% | 75.00% | 60.00% | $1,000,000 | $187,453 | 7 |
| LOW EQUIP. PRICE | $193.319 | 1000 | 10.00% | 75.00% | 60.00% | $600,000 | $187,453 | 7 |
| HIGH OP. EXPENSES | $261.260 | 1000 | 10.00% | 75.00% | 60.00% | $800,000 | $234,316 | 7 |
| LOW OP. EXPENSES | $223.772 | 1000 | 10.00% | 75.00% | 60.00% | $800,000 | $140,589 | 7 |
| LONG USEFUL LIFE | $221.313 | 1000 | 10.00% | 75.00% | 60.00% | $800,000 | $140,589 | 9 |
| SHORT USEFUL LIFE | $251.246 | 1000 | 10.00% | 75.00% | 60.00% | $800,000 | $140,589 | 5 |

## CHAPTER 6: HOLTER AND REAL-TIME TECHNOLOGIES

In this chapter we examine two technologies for ambulatory cardiac monitoring. The rapidly changing technology in this area, the uncertainty produced by these changes, and the pressures brought to bear on setting payment levels all make this problem a good one for illustrating the issues raised in this report. First we describe the evolution of the technologies. Then we define and analyze Holter recording, Holter scanning, and real-time analysis. Finally, we discuss the issues raised by this technology with respect to setting appropriate payment levels for diagnostic technologies.

### BACKGROUND ON HOLTER AND REAL-TIME TECHNOLOGIES

Ambulatory cardiac monitoring for years was synonymous with analog Holter monitoring. Holter monitoring is a two-part process in which: (i) the EKG wave form is continuously tape recorded over at least 24 hours using a small portable recorder; (ii) a system later replays the full recording for visual or computer-aided analysis. This analysis frequently includes super-imposition scanning, which is an analysis of the tape by a technician using a high speed scanning machine.

Procedures which include the superimposition scanning have been billed under code 93262.* Ambulatory cardiac monitoring procedures also carry a special set of "Q" codes, which provide more detail than the HCPCS codes. There are two technical fees for Holter monitoring, one for the recording, which includes hook-up and disconnect (Q0020), and one for the scanning and

*Electrocardiographic monitoring, 12-24 hours of continuous analog recording with physician review, interpretation and report with or without full disclosure printout; with superimposition scanning.

analysis (Q0021). Procedures which do not include the superimposition scanning fall under code 93263, which is broken down into Q codes for recording (Q0024) and for reporting (Q0025).

Some physicians (especially specialists) have their own scanning equipment and have their tapes scanned by their own employees. Others send the tapes out to companies which specialize in providing scanning services. Holter is a continuously recorded, continuously analyzed (ex-post) technology. The data furnished is usually comprehensive enough to evaluate patients for:

- o heart rate
- o ventricular arrythmia
- o supraventricular arrhythmia
- o pauses
- o atrial-ventricular conduction disturbances
- o intraventricular conduction
- o pacemaker function
- o ST segment changes

Recently, however, several types of portable monitors that record information in digitized form on a computer memory chip have been introduced. In the past, computer chip recorders were always referred to as "real-time" monitors. Real time technology historically had a limited memory capacity, and used a built-in computer algorithm to decide which portions of the EKG wave form would be recorded. These recorders essentially did the analysis in "real time", as the signals were produced by the patient. These procedures are billed under code 93266, which includes Q0027-Q0032. We will analyze Q0028, the technical portion of real-time analysis.

More recently, increased memory capacity and data compression techniques have produced solid state memory recorders which are similar to the Holter recorder in that they can continuously record 24 hours of information. These are not real-time recorders in the literal sense because they record and store

comprehensively for 24 hours. The latest developments allow the solid state technology version of superimposition scanning. The memory from the "full disclosure" devices can be loaded into a personal computer, and software can analyze the information and produce a report. Procedures using the new solid state technology have been billed under both 93262 (with superimposition scanning) and 93263 (no superimposition scanning).

The quality of the solid state devices relative to the analog Holter recording and scanning has been much debated. Recently, the Health Care Financing Administration decided to ignore the technological distinctions, and to pay the same rate for the same reporting capability. Which technologies and specific manufacturers provide the same capability, and the same quality capability, has been in dispute. This analysis will retain the technological distinction between these devices, and for each billing code will determine normal-return prices for each of the two types of technology. The different cells for analysis are noted by X's as shown below:

| HCPCS CODE | | Q CODE | ANALOG | DIGITAL |
|---|---|---|---|---|
| 93262 (Holter) | (recording) | Q0020 | X | X |
| | (scanning) | Q0021 | X | X |
| 93266 (Real time) | (record & scan) | Q0028 | | X |

BMAD data is <u>not</u> the source of price information used to calculate the normal-return volumes for the cardiac monitoring analyses. The 1986 BMAD data analyzed in Chapter 2 come from a period prior to the implementation of the more detailed "Q" codes. Instead, in this chapter, the price data used are more recent Medicare mean <u>prevailing</u> Q code charges collected in a survey of

carriers. These have been inflated to current dollars using the same methodology used for inflation of the BMAD prices. The prevailing charges are no doubt higher than the mean allowed charges, but still provide a basis of comparison.

HOLTER RECORDING

Holter recording (93262, Q0020) will be analyzed in this section. First, analog (tape) Holter recording technology will be analyzed, followed by digital Holter technology. For each, the usual normal-return prices and volumes will be calculated for the four types of scenarios.

Analog Technology

Code Q0020 is used for the technical part of Holter monitoring having to do with the actual recording of the patient's EKG waves, including hook-up and disconnect. The Holter recorder is a small tape unit worn by the patient over a 24 hour period. The hook-up and disconnect may be done by anyone from a secretary to an cardiac technologist or RN. The assumption is made that specialists use more highly trained, and therefore expensive, personnel to do the procedure. The recorder is about the size of a Walkman-type tape player, and therefore is assumed to require no incremental overhead expense.

One hundred percent utilization is assumed. Billing procedure for the device can either be Q0019 or Q0020. The global code for Holter monitoring (Q0019) is the sum of the parts Q0020 - recording, Q0021 - scanning, and Q0022 - professional fee. The annual volume assumed could be attributable to billing under either code; in either case the portion attributable to hook-up, recording, and disconnect would have the same costs. That is, this analysis is intended to capture the total fee for the hook-up, recording, and

disconnect for either Q0019 or Q0020. Data for annual volumes were not available. The estimates used were based on annual numbers of visits by specialty, and on the natural limit of about 250 procedures per year. Since the recorder is used over a 24 hour period, this is the maximum number of times per year a recorder could be used.

As the purchase price is relatively low, it is assumed that no money is borrowed to buy the recorder. Useful lives reflect an estimated average of historical useful life; advances in technology make it somewhat risky to assume that the devices will necessarily have the same expected life into the future.

The results of the analysis indicate that the normal-return prices for hook-up, recording, and disconnect for volumes in the 50-250 procedures per year range do not exceed $27.07 under the mid-range assumptions, and do not exceed $33.10 under sensitivity analysis. The normal-return price for a low-end non-specialist under a very low volume assumption (50/year) using very inexpensive equipment is $19.35. This is significantly lower than the $50.38 Medicare mean prevailing charge. No specialty adjustment was available in the prevailing charge data; however, the mean prevailing charge for all specialties is approximately $17 higher than the normal-profit high-end specialist's price.

Using the Medicare mean prevailing charge as the price received by the physician is somewhat imprecise, but because there is some uncertainty about the volume estimates, it is useful to use these prices to get a rough estimate of normal-return volumes. Annual volumes required for normal-return at the Medicare price ranged from 7 for low-end non-specialists to 23 for high-end specialists, or one to two procedures per month.

The results were most sensitive to variations in operating expenses, which include personnel, supplies, maintenance, and overhead. The results were quite insensitive to the other factors, including volume. Because the capital cost is relatively low, a 25% increase or decrease in volume for a high-end specialist only changes the normal-return price by about $1 from the $27.07 baseline. However, a very large increase in operating expenses would be required to bring the normal-return price near the Medicare mean prevailing charge. (See sensitivity analysis Tables 28a - 32b at the end of this chapter.)

Digital Technology

Digital Holter recorders are considerably more expensive than analog Holter recorders. The top end price for the analog technology is in the neighborhood of $2200, whereas the top end digital model is about 10 times as much, at $22,000. On the other hand, an inexpensive digital model may be much less expensive than the top end model. The other expenses associated with the digital recorders are very much the same as those for the analog recorders, with the exception of supplies. The Holter tape recorder has higher supplies expenses, due in part to the cassette tapes used. The digital model stores its data in a built in chip, which can later be loaded into a computer (any data storage costs are attributed to the scanning procedure Q0021).

Due in part to the higher cost of the monitor, the normal-return prices for the digital recorders are higher, especially in the high-end scenarios. The normal-return price ranges from $26.84 for a low-end non-specialist to $94.20 for a high-end non-specialist. The reason for this high price for the high-end non-specialist is the combination of low volume of procedures assumed

and expensive equipment. On the low end, the normal-return price is most sensitive to operating expenses. This is usually the case for technologies with low initial purchase prices. The normal-return price ranges from $23.48 to $30.21 with 25% changes in operating expenses for a low-end non-specialist. The much larger capital investment required for the high-end recorders is reflected in volume being the most sensitive factor for the break-even price. A high-end specialist's normal-return price ranges from $55.12 to $80.50 with 25% changes in volume.

These prices can also be compared with the same Medicare mean prevailing charge of $50.38. At this charge (in contrast to the analog case), at least some providers will not be overpaid for digital recording. At this charge, normal-return volumes range from 56 procedures per year for a low-end non-specialist to 228 procedures for high-end specialist. In contrast to the analog technology, the digital technology appears to be reimbursed at less than cost in some cases.

HOLTER SCANNING

The analysis for recording (Q0020) does not, however, tell the whole story. The results for the scanning portion of the procedure, Q0021, have quite different results.

Holter scanning is billed under code Q0021. In the past, scanning would only have referred to the process of analyzing Holter analog tape recordings. With advances in technology, a similar process can be used to analyze the results of digitally recorded EKG waves with the use of a personal computer. Below both types of technologies are analyzed.

Analog Holter Scanning

An analog Holter tape is scanned using a fairly expensive ($30,000 - $60,000) Holter scanner. There are no official standards or licensure requirements as to the type of training required to conduct a scan. The scans are done by personnel with a variety of backgrounds. Scanning services provide relatively extensive training for their personnel, who may be RN's. Some physicians may use personnel without as much clinical background. The quality of the analysis varies depending on the qualifications and experience of the personnel. The procedure usually takes about one hour to perform.

The equipment does take up some floor space, about the same or a little more than a personal computer. The useful life of the equipment has historically been fairly long for medical equipment, although scanning services and specialists concerned with having the latest technology choose shorter useful lives. The service life assumed in the analysis varies from 6 to 10 years. The Holter scanner can only be used for scanning Holter tapes, therefore its utilization is 100% for this procedure (Again, Q0021 is a sub-component of Q0019 -- costs will be the same regardless of how it is billed.)

Supplies costs are minimal at around $2 per procedure, mostly for paper and printing-related items. As the machines are expensive, for some of the scenarios it is assumed that a large portion of the capital expense is borrowed.

The annual volume figures here are again based on rough but plausible estimates. Some scanning services and large group practices run their machines at full capacity of 8-9 procedures per day, or around 2,000 procedures per year. It is unlikely that a solo practitioner will approach this volume, especially since this is about the number of patient contacts a

cardiologist will have in any one year. The volume levels assumed vary from 200-500 procedures per year, or 4-10 per week.

The results of the analysis show that the normal-return prices vary, depending largely on how expensive the equipment is and how large the volume is. A low-end non-specialist has a normal-return price of $23.03, whereas a high-end specialist's price is far higher at $122.36. For those who pay for the entire machine up front, large annual net cash flows offset the high initial purchase price of the equipment.

The normal-return prices are most sensitive to operating expenses for the low-end non-specialist, who is assumed to use less expensive equipment. His price ranges from $19.15 to $26.90 with 25% variations in operating expenses. Volume is also important in the non-specialists' break-even price. The specialist's price is most sensitive to volume, due to the $60,000 initial purchase price of his equipment. His normal-return price varies from $101.49 to $157.13 with 25% changes in volume. The high-end provided results are also sensitive to variations in equipment price, and somewhat so to operating price.

The Medicare mean prevailing charge for scanning is $116.30 for all specialties. This is close to the normal-return price for analog scanning for specialists, but far above the normal-return price for non-specialists. A specialist would need to provide 193 procedures per year at this price, whereas a non-specialist would only need to provide 48.

Digital Scanning

Digital scanning uses a software written for personal computers to do its analysis. The reports can be printed on printers used with personal compu-

ters. The capital expense required for this procedure will vary depending on what we assume about the other uses of the personal computer, and whether the physician already had a personal computer and only needed to purchase the software. Assumptions are varied from a minimal capital expense required of $500, to a larger expense of $5,000 required to purchase a computer and printer. This is a far lower capital expenditure than is required for the analog Holter scanner.

Personnel time is also far less for this procedure. The computer essentially does all the analysis, rather than the visual analysis done by the technician in the analog case. A person is needed only to load the data into the computer, and to start the analysis running. There has been some debate as to the quality of the job done by the computerized analyzers. The combination of lower capital expense and lower personnel expense make the digital scan far less expensive than the analog scan.

The break-even price for the digital scan for a specialist is $14.28, assuming that he had to purchase all the equipment and uses the computer for no other purpose. Relaxing these assumption to lower the utilization to 25% for this procedure, and the capital expense to $500, produces a normal-return price of only $3.48 at 500 procedures per year. While the specialists' price may vary between $12.24 and $17.64 if we vary volume 25%, the low-end non-specialists' price will vary from $2.85 to $4.36 as operating expenses are varied 25%.

Under any reasonable and even some unreasonably high assumptions, mean Medicare charges of $116.30 are far in excess of the costs of production for

analog scanning. The normal-return volumes at the Medicare mean prevailing charge are therefore very low, ranging from 1-20 procedures per year.

REAL-TIME ANALYSIS

A real-time monitor differs from a Holter monitor in two basic ways. First, it only records selected periods of the EKG wave form, that is, it is not continuous recording. Second, it has a built in computer algorithm to determine which periods it will record in its solid state memory. The algorithm is designed to detect problem wave forms and to analyze them. There are large variations in the quality and capabilities of these machines. The better machines are able to detect and analyze a wider range of problems than the less expensive machines.

The wide range in capability of the machines is reflected in the wide price range of the equipment. Real-time recorders can cost anywhere from $5000 to over $20,000. Largely because of this, the normal-return prices for the different scenarios also have a wide range, from $18.48 in the low-end non-specialist case to $94.20 in the high-end specialist case. The intermediate cases have normal-return prices of $56.84 and $25.91. This variation would seem to indicate that the same product is not being produced by the different types of machines, and this is probably true. Except for the high-end specialist, these prices are still significantly less than the Medicare annual mean prevailing charge of $119.05. The normal-return volumes based on the Medicare mean prevailing charge of $119.05 range from 16 for a low-end non-specialist to 53 for a high-end specialist.

Both the high-end specialist and the low-end non-specialist cases were most sensitive to changes in annual volume. A 25% change in volume causes the

low-end non-specialist price to range from $16.81 to $21.27, and the high-end specialist case to range from $77.90 to $121.37. Good volume data for this procedure was not available, so reasonable estimates were made. Taking this into consideration along with the sensitivity results, the normal-return prices must be interpreted with caution.

ISSUES RAISED BY AMBULATORY CARDIAC MONITORING

There have been several problems surrounding the use of digital and real-time technology. The fundamental problem is the uncertainty created by rapidly changing technology, and the differences in the ability of some manufacturers and physicians to adjust to the uncertainty and the new opportunities it presents. These instruments and their manufacturers vary widely in quality and reliability. Equipment made by less reputable companies is not sufficiently tested for accuracy or reliability. Some manufacturers have marketed less expensive and technically less adequate equipment with overt references to Medicare reimbursement levels and high profitability at low volume levels. Despite the limitations of real-time analysis units and the American College of Cardiologists' position that the technology was experimental, manufacturers of this equipment obtained full third-party reimbursement. Before the 1987 version of the HCPCS the codes did not reliably distinguish between Holter and other ambulatory monitoring. Both Holter and real-time analysis could be coded under the Holter code. Thus a unit capable of reporting, say, only on heart rate and ventricular arrhythmia had at one point the same reimbursement as a conventional Holter monitor. Many billings were alleged to involve costs and quality much below what the payment levels assumed.

There has been as much uncertainty about what the technologies can actually do as there has about their value. Defining the product or output clearly seems to be a necessary first step to reasonable pricing. It is desirable to develop a rational analytical method to (i) assess a technology and (ii) define an appropriate level of payment. Also, setting payments and standards at appropriate levels will reduce the opportunities for unethical manufacturers and physicians. The main problem in short, is that Medicare has been unable to adapt its definition of what contributes acceptable performance of these tests to rapid technical change.

The following are issues surrounding the ambulatory cardiac monitoring which were unresolved or unclear. The list might also serve as an outline for how to proceed further in defining the appropriate payment level.

1. Defining the Required Minimum Output and Quality of the Technical Portion of a Procedure

An important definition missing is that of the ambulatory cardiac monitoring report. There is no accepted definition of a report's contents. The American College of Cardiologists has published standards on frequency response, signal distortion, etc., but a pronouncement on gradations of monitoring comprehensiveness is needed to establish gradations of payment (and the corresponding code structure).

2. Determining the Value of the Technical Portion

Finding an appropriate method of valuing the technical portion is the issue our report addresses and, as noted therein, there are three approaches one could take to accomplish this:

i) Cost + rate-of-return-based

ii) Access or volume-based

iii) Private sector bargaining based

3. Defining the Output and Quality of Specific Equipment

In addition to defining the product and determining its value, the ability of individual types of equipment to produce the required output and quality needs to be assessed. The capabilities of the real-time monitoring equipment was frequently in question. Uncertainty arose as to what specific pieces of equipment were designed to monitor, detect, and/or record.

All three of these steps are important in setting the proper payment level. The physician has been entrusted with making the proper decision as to the quality and capability of diagnostic equipment. This can lead to problems when the physician is either not qualified to distinguish different quality levels (as my happen when some generalists use real-time monitoring equipment) or when the physician is unethical and runs large numbers of highly reimbursed tests using inadequate and inexpensive equipment.

The recent development of digital Holter scanning illustrates these points. The technology has only recently been developed, and is changing quickly. The payment level for the service is the same as that for the old technology, even though our analysis has shown that it may cost from 1/10th to 1/20th as much to produce. However, it is difficult to tell if the new process can produce comparable results to the old technology. Do all the manufacturers' equipment produce the same results?

The case of ambulatory cardiac monitoring tells us something about trying to determine reasonable prices for diagnostic equipment using a rate-of-return methodology:

i) The results of step 2 above (essentially our study results) will not identify the appropriate level of payment for the technical portion of the service unless that technical output is well-defined.

ii) Even assuming steps 1 and 2 above are executed, when technology changes quickly, Medicare may still be paying inappropriately for some services if it has not defined the output/quality of specific equipment.

These other issues are not within the scope of our project, but they need to be considered in addressing the larger issue of appropriate payment for services.

## CONCLUSION

In addressing whether payments for Holter recording and scanning are appropriate based on a market rate of return, we must look at data for recording (Q0020) and scanning (Q0021) together. For analog Holter, the combined normal-return price ranges from $42.38 to $149.43 depending on the scenario. The sum of the mean prevailing Medicare charges is $166.68. The largest part of this difference is attributable to Holter recording, which is consistently less expensive to produce than the prevailing charge. Holter scanning is appropriately priced for specialists with low volumes; however, even for this group the combined normal-return price is less than the Medicare average.

Digital Holter testing also seems to be over-priced, but by a much larger amount in absolute terms. The sum of the normal-return prices for Q0020 and Q0021 ranges from $21.96 to $78.93, compared to the same $166.68 combined prevailing price. The difference between digital and analog Holter is almost entirely attributable to scanning. The digital scanning technology is far less expensive than its analog counterpart. The normal-return price for scanning alone in the most expensive scenario is $14.28, as compared to the mean prevailing charge of $116.30. Digital Holter recording, alone, on the other hand, is close to being reimbursed at the appropriate price. The digital Holter technology is less expensive overall than the analog, but digital recording is relatively more expensive than analog recording, and vice versa for scanning.

Real-time analysis, normal-return prices range from $18.48 to $94.20 as compared to the mean prevailing charge of $119.05. The procedure appears to be overpriced for all categories.

Holter monitoring of either type appears to have normal-return prices below the mean Medicare prevailing charges. As this procedure is increasingly converted to using less costly digital technology, the gap between the prevailing charge and the normal-return price will become more significant. Real-time analysis also had normal-return prices below the mean prevailing charge under most reasonable sets of assumptions. Precise definition of the output of the technical component and the ability of specific equipment to produce the defined output are important issues for all ambulatory cardiac monitoring technologies.

Table 27
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS FOR HOLTER AND REAL-TIME TECHNOLOGIES

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|
| CODE: 93262 (Q0020) DESCRIPTION: HOLTER ANALOG RECORDING | | | | | | | |
| Non-specialist low | 150 | 19.35 | | N.A. | 7 | Oper. Exp. | 14.85 - 23.85 |
| Non-specialist high | 50 | 25.99 | | | 11 | | |
| | | | 50.38 | | | | |
| Specialist low | 250 | 22.83 | | | 13 | | |
| Specialist high | 180 | 27.07 | | N.A. | 23 | Oper. Exp. | 21.02 - 33.10 |
| CODE: 93262 (Q0021) DESCRIPTION: HOLTER ANALOG SCANNING | | | | | | | |
| Non-specialist low | 500 | 23.03 | | N.A. | 48 | Oper. Exp. | 19.15 - 26.90 |
| Non-specialist high | 200 | 56.54 | | | 78 | | |
| | | | 118.30 | | | | |
| Specialist low | 400 | 36.92 | | | 87 | | |
| Specialist high | 200 | 122.36 | | N.A. | 193 | Volume | 101.49 - 157.13 |
| CODE: 93262 (Q0020) DESCRIPTION: DIGITAL HOLTER RECORDING | | | | | | | |
| Non-specialist low | 150 | 26.84 | | N.A. | 56 | Volume | 23.50 - 32.42 |
| Non-specialist high | 50 | 94.20 | | | 97 | | |
| | | | 50.38 | | | | |
| Specialist low | 250 | 30.74 | | | 108 | | |
| Specialist high | 180 | 64.65 | | N.A. | 228 | Volume | 55.12 - 80.5 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 27 (cont.)
SUMMARY OF INCREMENTAL CASH FLOW ANALYSIS FOR HOLTER AND REAL-TIME TECHNOLOGIES

| | Assumed Volume/ Per Year | Normal-Return Price | Average Medicare MEI Price Updated to 1988 | Specialty Specific Medicare Prices MEI Updated (2) | Normal-Return Volume/ Per Year | Most Sensitive to Factor | Sensitive Price Range +/- 25% |
|---|---|---|---|---|---|---|---|
| CODE: 93262 (Q0021) DESCRIPTION: DIGITAL HOLTER SCANNING | | | | | | | |
| Non-specialist low | 500 | 3.48 | | N.A. | 1 | Oper. Exp. | 2.85 - 4.36 |
| Non-specialist high | 200 | 5.78 | | | 3 | | |
| | | | 116.30 | | | | |
| Specialist low | 400 | 3.71 | | | 1 | | |
| Specialist high | 200 | 14.28 | | N.A. | 17 | Volume | 12.24 - 17.64 |
| CODE: 93266 (Q0028) DESCRIPTION: REAL TIME ANALYSIS | | | | | | | |
| Non-specialist low | 150 | 18.48 | | N.A. | 16 | Volume | 16.81 - 21.27 |
| Non-specialist high | 50 | 56.84 | | | 29 | | |
| | | | 119.05 | | | | |
| Specialist low | 150 | 25.91 | | | 25 | | |
| Specialist high | 50 | 94.20 | | N.A. | 53 | Volume | 77.90 - 121.37 |

Notes: (1) Cash Flow Analysis assumes a required rate of return of 10%
(2) Average BMAD charges per procedure updated to 1988 for type of physician identified as "specialist" or "non-specialist"

Table 28a

SENSITIVITY ANALYSIS : HOLT TAPE REC

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $19.35 | 150 | 10.00% | 0.00% | 100.00% | $1,000 | $2,703 | 8 |
| HIGH ANN. PROCEDURES | $19.02 | 187.5 | 10.00% | 0.00% | 100.00% | $1,000 | $2,703 | 8 |
| LOW ANN. PROCEDURES | $19.92 | 112.5 | 10.00% | 0.00% | 100.00% | $1,000 | $2,703 | 8 |
| HIGH COST OF CAPITAL | $19.52 | 150 | 12.50% | 0.00% | 100.00% | $1,000 | $2,703 | 8 |
| LOW COST OF CAPITAL | $19.20 | 150 | 7.50% | 0.00% | 100.00% | $1,000 | $2,703 | 8 |
| LOW % UTILIZATION | $18.94 | 150 | 10.00% | 0.00% | 75.00% | $1,000 | $2,703 | 8 |
| HIGH % UTILIZATION | $19.35 | 150 | 10.00% | 0.00% | 100.00% | $1,000 | $2,703 | 8 |
| HIGH % CAP. BORROWED | $19.24 | 150 | 10.00% | 25.00% | 100.00% | $1,000 | $2,703 | 8 |
| HIGH EQUIP. PRICE | $19.77 | 150 | 10.00% | 0.00% | 100.00% | $1,250 | $2,703 | 8 |
| LOW EQUIP. PRICE | $18.93 | 150 | 10.00% | 0.00% | 100.00% | $750 | $2,703 | 8 |
| HIGH OP. EXPENSES | $23.86 | 150 | 10.00% | 0.00% | 100.00% | $1,000 | $3,379 | 8 |
| LOW OP. EXPENSES | $14.85 | 150 | 10.00% | 0.00% | 100.00% | $1,000 | $2,027 | 8 |
| LONG USEFUL LIFE | $19.17 | 150 | 10.00% | 0.00% | 100.00% | $1,000 | $2,703 | 10 |
| SHORT USEFUL LIFE | $19.65 | 150 | 10.00% | 0.00% | 100.00% | $1,000 | $2,703 | 6 |

Table 28b

**SENSITIVITY ANALYSIS: HOLT TAPE REC.**

**Specialist** **High Cost**

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $27.07 | 180 | 10.00% | 0.00% | 100.00% | $2,100 | $4,355 | 6 |
| HIGH ANN. PROCEDURES | $26.25 | 225 | 10.00% | 0.00% | 100.00% | $2,100 | $4,355 | 6 |
| LOW ANN. PROCEDURES | $28.42 | 135 | 10.00% | 0.00% | 100.00% | $2,100 | $4,355 | 6 |
| HIGH COST OF CAPITAL | $27.35 | 180 | 12.50% | 0.00% | 100.00% | $2,100 | $4,355 | 6 |
| LOW COST OF CAPITAL | $26.77 | 180 | 7.50% | 0.00% | 100.00% | $2,100 | $4,355 | 6 |
| LOW % UTILIZATION | $26.05 | 180 | 10.00% | 0.00% | 75.00% | $2,100 | $4,355 | 6 |
| HIGH % UTILIZATION | $27.07 | 180 | 10.00% | 0.00% | 100.00% | $2,100 | $4,355 | 6 |
| HIGH % CAP. BORROWED | $26.80 | 180 | 10.00% | 25.00% | 100.00% | $2,100 | $4,355 | 6 |
| HIGH EQUIP. PRICE | $28.08 | 180 | 10.00% | 0.00% | 100.00% | $2,625 | $4,355 | 6 |
| LOW EQUIP. PRICE | $26.06 | 180 | 10.00% | 0.00% | 100.00% | $1,575 | $4,355 | 6 |
| HIGH OP. EXPENSES | $33.10 | 180 | 10.00% | 0.00% | 100.00% | $2,100 | $5,444 | 6 |
| LOW OP. EXPENSES | $21.02 | 180 | 10.00% | 0.00% | 100.00% | $2,100 | $3,267 | 6 |
| LONG USEFUL LIFE | $26.56 | 180 | 10.00% | 0.00% | 100.00% | $2,100 | $4,355 | 8 |
| SHORT USEFUL | $27.59 | 180 | 10.00% | 0.00% | 100.00% | $2,100 | $4,355 | 5 |

Table 29a

SENSITIVITY ANALYSIS: HOLT DIGITAL REC.

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $18.69 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH ANN. PROCEDURES | $16.91 | 187.5 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| LOW ANN. PROCEDURES | $21.87 | 112.5 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH COST OF CAPITAL | $19.24 | 150 | 12.50% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| LOW COST OF CAPITAL | $18.03 | 150 | 7.50% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| LOW % UTILIZATION | $16.20 | 150 | 10.00% | 50.00% | 75.00% | $5,000 | $1,769 | 6 |
| HIGH % UTILIZATION | $18.39 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH % CAP. BORROWED | $18.09 | 150 | 10.00% | 62.50% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH EQUIP. PRICE | $20.56 | 150 | 10.00% | 50.00% | 100.00% | $6,250 | $1,769 | 6 |
| LOW EQUIP. PRICE | $16.40 | 150 | 10.00% | 50.00% | 100.00% | $3,750 | $1,769 | 6 |
| HIGH OP. EXPENSES | $21.45 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $2,211 | 6 |
| LOW OP. EXPENSES | $15.57 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,327 | 6 |
| LONG USEFUL LIFE | $17.24 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 8 |
| SHORT USEFUL | $19.73 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 5 |

Table 29b

SENSITIVITY ANALYSIS : HOLT DIGITAL REC.

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $64.65 | 180 | 10.00% | 0.00% | 100.00% | $22,000 | $5,265 | 5 |
| HIGH ANN. PROCEDURES | $55.12 | 225 | 10.00% | 0.00% | 100.00% | $22,000 | $5,265 | 5 |
| LOW ANN. PROCEDURES | $80.50 | 135 | 10.00% | 0.00% | 100.00% | $22,000 | $5,265 | 5 |
| HIGH COST OF CAPITAL | $67.89 | 180 | 12.50% | 0.00% | 100.00% | $22,000 | $5,265 | 5 |
| LOW COST OF CAPITAL | $61.50 | 180 | 7.50% | 0.00% | 100.00% | $22,000 | $5,265 | 5 |
| LOW % UTILIZATION | $52.79 | 180 | 10.00% | 0.00% | 75.00% | $22,000 | $5,265 | 5 |
| HIGH % UTILIZATION | $64.65 | 180 | 10.00% | 0.00% | 100.00% | $22,000 | $5,265 | 5 |
| HIGH % CAP. BORROWED | $61.49 | 180 | 10.00% | 25.00% | 100.00% | $22,000 | $5,265 | 5 |
| HIGH EQUIP. PRICE | $76.56 | 180 | 10.00% | 0.00% | 100.00% | $27,500 | $5,265 | 5 |
| LOW EQUIP. PRICE | $52.72 | 180 | 10.00% | 0.00% | 100.00% | $16,500 | $5,265 | 5 |
| HIGH OP. EXPENSES | $71.97 | 180 | 10.00% | 0.00% | 100.00% | $22,000 | $6,582 | 5 |
| LOW OP. EXPENSES | $57.31 | 180 | 10.00% | 0.00% | 100.00% | $22,000 | $3,949 | 5 |
| LONG USEFUL LIFE | $59.30 | 180 | 10.00% | 0.00% | 100.00% | $22,000 | $5,265 | 6 |
| SHORT USEFUL LIFE | $65.60 | 180 | 10.00% | 0.00% | 100.00% | $22,000 | $5,265 | 4 |

Table 30a

SENSITIVITY ANALYSIS : HOLTER SCANNING

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $23.03 | 500 | 10.00% | 75.00% | 100.00% | $30,000 | $7,735 | 10 |
| HIGH ANN. PROCEDURES | $20.88 | 625 | 10.00% | 75.00% | 100.00% | $30,000 | $7,735 | 10 |
| LOW ANN. PROCEDURES | $26.62 | 375 | 10.00% | 75.00% | 100.00% | $30,000 | $7,735 | 10 |
| HIGH COST OF CAPITAL | $23.50 | 500 | 12.50% | 75.00% | 100.00% | $30,000 | $7,735 | 10 |
| LOW COST OF CAPITAL | $22.45 | 500 | 7.50% | 75.00% | 100.00% | $30,000 | $7,735 | 10 |
| LOW % UTILIZATION | $20.17 | 500 | 10.00% | 75.00% | 75.00% | $30,000 | $7,735 | 10 |
| HIGH % UTILIZATION | $23.03 | 500 | 10.00% | 75.00% | 100.00% | $30,000 | $7,735 | 10 |
| HIGH % CAP. BORROWED | $22.33 | 500 | 10.00% | 93.75% | 100.00% | $30,000 | $7,735 | 10 |
| HIGH EQUIP. PRICE | $25.67 | 500 | 10.00% | 75.00% | 100.00% | $37,500 | $7,735 | 10 |
| LOW EQUIP. PRICE | $20.39 | 500 | 10.00% | 75.00% | 100.00% | $22,500 | $7,735 | 10 |
| HIGH OP. EXPENSES | $26.90 | 500 | 10.00% | 75.00% | 100.00% | $30,000 | $9,668 | 10 |
| LOW OP. EXPENSES | $19.15 | 500 | 10.00% | 75.00% | 100.00% | $30,000 | $5,801 | 10 |
| LONG USEFUL LIFE | $22.35 | 500 | 10.00% | 75.00% | 100.00% | $30,000 | $7,735 | 13 |
| SHORT USEFUL LIFE | $24.17 | 500 | 10.00% | 75.00% | 100.00% | $30,000 | $7,735 | 8 |

Table 30b

SENESITIVITY ANALYSIS : HOLTER SCANNING

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $122.36 | 200 | 10.00% | 0.00% | 100.00% | $60,000 | $9,718 | 6 |
| HIGH ANN. PROCEDURES | $101.49 | 250 | 10.00% | 0.00% | 100.00% | $60,000 | $9,718 | 6 |
| LOW ANN. PROCEDURES | $157.13 | 150 | 10.00% | 0.00% | 100.00% | $60,000 | $9,718 | 6 |
| HIGH COST OF CAPITAL | $130.18 | 200 | 12.50% | 0.00% | 100.00% | $60,000 | $9,718 | 6 |
| LOW COST OF CAPITAL | $114.80 | 200 | 7.50% | 0.00% | 100.00% | $60,000 | $9,718 | 6 |
| LOW % UTILIZATION | $96.29 | 200 | 10.00% | 0.00% | 75.00% | $60,000 | $9,718 | 6 |
| HIGH % UTILIZATION | $122.36 | 200 | 10.00% | 0.00% | 100.00% | $60,000 | $9,718 | 6 |
| HIGH % CAP. BORROWED | $115.59 | 200 | 10.00% | 25.00% | 100.00% | $60,000 | $9,718 | 6 |
| HIGH EQUIP. PRICE | $148.30 | 200 | 10.00% | 0.00% | 100.00% | $75,000 | $9,718 | 6 |
| LOW EQUIP. PRICE | $96.42 | 200 | 10.00% | 0.00% | 100.00% | $45,000 | $9,718 | 6 |
| HIGH OP. EXPENSES | $134.50 | 200 | 10.00% | 0.00% | 100.00% | $60,000 | $12,147 | 6 |
| LOW OP. EXPENSES | $110.21 | 200 | 10.00% | 0.00% | 100.00% | $60,000 | $7,288 | 6 |
| LONG USEFUL LIFE | $108.57 | 200 | 10.00% | 0.00% | 100.00% | $60,000 | $9,718 | 8 |
| SHORT USEFUL LIFE | $135.49 | 200 | 10.00% | 0.00% | 100.00% | $60,000 | $9,718 | 5 |

Table 31a

SENSITIVITY ANALYSIS: HOLT DIGITAL SCAN

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $3.46 | 500 | 10.00% | 0.00% | 25.00% | $500 | $1,715 | 7 |
| HIGH ANN. PROCEDURES | $3.46 | 625 | 10.00% | 0.00% | 25.00% | $500 | $1,715 | 7 |
| LOW ANN. PROCEDURES | $3.62 | 375 | 10.00% | 0.00% | 25.00% | $500 | $1,715 | 7 |
| HIGH COST OF CAPITAL | $3.46 | 500 | 11.50% | 0.00% | 25.00% | $500 | $1,715 | 7 |
| LOW COST OF CAPITAL | $3.46 | 500 | 7.50% | 0.00% | 25.00% | $500 | $1,715 | 7 |
| LOW % UTILIZATION | $3.46 | 500 | 10.00% | 0.00% | 18.75% | $500 | $1,715 | 7 |
| HIGH % UTILIZATION | $3.51 | 500 | 10.00% | 0.00% | 31.25% | $500 | $1,715 | 7 |
| HIGH % CAP. BORROWED | $3.48 | 500 | 10.00% | 25.00% | 25.00% | $500 | $1,715 | 7 |
| HIGH EQUIP. PRICE | $3.50 | 500 | 10.00% | 0.00% | 25.00% | $625 | $1,715 | 7 |
| LOW EQUIP. PRICE | $3.47 | 500 | 10.00% | 0.00% | 25.00% | $375 | $1,715 | 7 |
| HIGH OP. EXPENSES | $4.36 | 500 | 10.00% | 0.00% | 25.00% | $500 | $2,143 | 7 |
| LOW OP. EXPENSES | $2.85 | 500 | 10.00% | 0.00% | 25.00% | $500 | $1,286 | 7 |
| LONG USEFUL LIFE | $3.48 | 500 | 10.00% | 0.00% | 25.00% | $500 | $1,715 | 9 |
| SHORT USEFUL | $3.50 | 500 | 10.00% | 0.00% | 25.00% | $500 | $1,715 | 5 |

Table 31b

**SENSITIVITY ANALYSIS: HOLT DIGITAL SCAN**

**Specialist** **High Cost**

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $14.21 | 200 | 10.00% | 0.00% | 100.00% | $5,000 | $1,408 | 5 |
| HIGH ANN. PROCEDURES | $11.28 | 250 | 10.00% | 0.00% | 100.00% | $5,000 | $1,408 | 5 |
| LOW ANN. PROCEDURES | $17.64 | 150 | 10.00% | 0.00% | 100.00% | $5,000 | $1,408 | 5 |
| HIGH COST OF CAPITAL | $14.96 | 200 | 12.50% | 0.00% | 100.00% | $5,000 | $1,408 | 5 |
| LOW COST OF CAPITAL | $13.64 | 200 | 7.50% | 0.00% | 100.00% | $5,000 | $1,408 | 5 |
| LOW % UTILIZATION | $11.72 | 200 | 10.00% | 0.00% | 75.00% | $5,000 | $1,408 | 5 |
| HIGH % UTILIZATION | $14.28 | 200 | 10.00% | 0.00% | 100.00% | $5,000 | $1,408 | 5 |
| HIGH % CAP. BORROWED | $13.64 | 200 | 10.00% | 25.00% | 100.00% | $5,000 | $1,408 | 5 |
| HIGH EQUIP. PRICE | $16.71 | 200 | 10.00% | 0.00% | 100.00% | $6,000 | $1,408 | 5 |
| LOW EQUIP. PRICE | $11.86 | 200 | 10.00% | 0.00% | 100.00% | $3,750 | $1,408 | 5 |
| HIGH OP. EXPENSES | $16.05 | 200 | 10.00% | 0.00% | 100.00% | $5,000 | $1,761 | 5 |
| LOW OP. EXPENSES | $12.53 | 200 | 10.00% | 0.00% | 100.00% | $5,000 | $1,056 | 5 |
| LONG USEFUL LIFE | $13.19 | 200 | 10.00% | 0.00% | 100.00% | $5,000 | $1,408 | 6 |
| SHORT USEFUL | $14.47 | 200 | 10.00% | 0.00% | 100.00% | $5,000 | $1,408 | 4 |

Table 32a

SENSITIVITY ANALYSIS: REAL TIME ANALYSIS

Non-Specialist Low Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $18.48 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH ANN. PROCEDURES | $16.81 | 187.5 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| LOW ANN. PROCEDURES | $21.27 | 112.5 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH COST OF CAPITAL | $18.95 | 150 | 12.50% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| LOW COST OF CAPITAL | $18.03 | 150 | 7.50% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| LOW % UTILIZATION | $16.31 | 150 | 10.00% | 50.00% | 75.00% | $5,000 | $1,769 | 6 |
| HIGH % UTILIZATION | $18.48 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH % CAP. BORROWED | $18.11 | 150 | 10.00% | 62.50% | 100.00% | $5,000 | $1,769 | 6 |
| HIGH EQUIP. PRICE | $20.57 | 150 | 10.00% | 50.00% | 100.00% | $6,250 | $1,769 | 6 |
| LOW EQUIP. PRICE | $16.40 | 150 | 10.00% | 50.00% | 100.00% | $3,750 | $1,769 | 6 |
| HIGH OP. EXPENSES | $21.43 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $2,211 | 6 |
| LOW OP. EXPENSES | $15.54 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,327 | 6 |
| LONG USEFUL LIFE | $15.22 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,327 | 8 |
| SHORT USEFUL LIFE | $17.03 | 150 | 10.00% | 50.00% | 100.00% | $5,000 | $1,327 | 5 |

Table 32b

SENSITIVITY ANALYSIS: REAL TIME ANALYSIS

Specialist High Cost

| | BREAK-EVEN PRICE | ANNUAL PROCEDURES | COST OF CAPITAL | % CAP. BORROWED | % UTILIZ. | EQUIP. PRICE | ANNUAL OP. EXPS. | USEFUL LIFE |
|---|---|---|---|---|---|---|---|---|
| BASE CASE | $94.20 | 50 | 10.00% | 0.00% | 100.00% | $12,000 | $1,234 | 5 |
| HIGH ANN. PROCEDURES | $77.90 | 62.5 | 10.00% | 0.00% | 100.00% | $12,000 | $1,234 | 5 |
| LOW ANN. PROCEDURES | $121.37 | 37.5 | 10.00% | 0.00% | 100.00% | $12,000 | $1,234 | 5 |
| HIGH COST OF CAPITAL | $100.55 | 50 | 12.50% | 0.00% | 100.00% | $12,000 | $1,234 | 5 |
| LOW COST OF CAPITAL | $88.02 | 50 | 7.50% | 0.00% | 100.00% | $12,000 | $1,234 | 5 |
| LOW % UTILIZATION | $73.83 | 50 | 10.00% | 0.00% | 75.00% | $12,000 | $1,234 | 5 |
| HIGH % UTILIZATION | $94.20 | 50 | 10.00% | 0.00% | 100.00% | $12,000 | $1,234 | 5 |
| HIGH % CAP. BORROWED | $87.99 | 50 | 10.00% | 25.00% | 100.00% | $12,000 | $1,234 | 5 |
| HIGH EQUIP. PRICE | $114.58 | 50 | 10.00% | 0.00% | 100.00% | $15,000 | $1,234 | 5 |
| LOW EQUIP. PRICE | $73.83 | 50 | 10.00% | 0.00% | 100.00% | $9,000 | $1,234 | 5 |
| HIGH OP. EXPENSES | $100.37 | 50 | 10.00% | 0.00% | 100.00% | $12,000 | $1,543 | 5 |
| LOW OP. EXPENSES | $88.04 | 50 | 10.00% | 0.00% | 100.00% | $12,000 | $926 | 5 |
| LONG USEFUL LIFE | $80.44 | 50 | 10.00% | 0.00% | 100.00% | $12,000 | $926 | 6 |
| SHORT USEFUL LIFE | $89.89 | 50 | 10.00% | 0.00% | 100.00% | $12,000 | $926 | 4 |

## CHAPTER 7: A SUGGESTED REMEDY AND CONCLUSIONS

### TOWARD A VOLUME-RELATED PAYMENT SYSTEM

Using NPV-based prices or even market-based prices falls short of the ideal payment system because of the strong effect of volume on the return on investment. No matter what price is set, high volume producers will earn above-normal returns, and will be able to increase profits by doing even more procedures. Is there then any alternative pricing strategy for HCFA? Designing a single-price system which even approximates a cost-coverage or fair return model is impossible when there are economies of scale or fixed costs. If, however, the form of the cost function is known, and if HCFA's objective, in addition to constraining reimbursements, is to discourage the purchase and/or use of in-office test equipment when volume falls below some minimum level, there is an alternative strategy. It is one which makes the unit price doctors receive conditional on the volume of the tests they provide over any time interval.

Let us first describe how the arrangement would work, and then show what its properties are. In the simplest initial case, all of the tests a doctor runs are assumed to be for Medicare patients. We first need to define a minimum volume of, say, M tests per time period. Doctors whose volume was be below this level would receive a price that is "low". Such a price could be zero, or it could simply be a price at volumes below the minimum desired volume M which is well below the estimate of the normal-return price or average cost at that volume. At volume M, and higher, we choose a price which covers average cost. As volume increases, the unit price falls in such a way as to remain equal to the normal-return price at any volume. This could be

accomplished with a continuously variable price or could be approximated by defining different prices for different ranges of volumes.

In a formal sense, such a scheme clearly will prevent volume from being related directly to profitability. At any volume, more efficient providers will still earn positive profits, and no provider who expects to earn losses will survive, so average profit will still be positive, but presumably much smaller than in the case in which no account is taken of volume. It clearly would be possible to use a frontier (most efficient practice) cost function rather than a typical firm cost function to eliminate less efficient providers if that was desired.

If the price system exactly tracks the cost function, physician incentives with regard to volume will be neutral. That is, the doctor will earn the same profit (normal return) regardless of volume. (Of course, if the price does not track costs quite exactly, there will be a slightly larger incentive to invest in a machine at high volume than at low volume, since a slight amount of profit per unit means more when the number of units is greater.)

The reason for the incentive-neutrality result is that the marginal price or revenue is less than average price, and is indeed equal to marginal cost. So incentives are neutral both with regard to more units of outputs, given that testing capability has been acquired, and with regard to investment in testing capability in the first instance.

If HCFA does have specific targets concerning volume levels it wants to encourage, the price schedule could be "tilted" away from exact equality with cost in order to encourage those volumes. Very efficient producers at other volume levels could still survive. Suppose, for instance, there is a desire

to encourage higher volume physicians if physicians are going to provide the tests in their offices at all. Then having a revenue function which is less steeply sloped than the cost function will encourage such practice. It will pay prices somewhat below the normal return price at low volumes, and perhaps prices somewhat above the normal-return price at high volumes. However, lower volume practices may still find it feasible, at only a modest sacrifice in test profit, to continue to furnish services if the competitive attraction of convenience for patients is great enough.

Designing this system is more complicated if a piece of equipment is also used for a substantial number of tests for non-Medicare patients. The simplest strategy would be to base the Medicare price on total volume, if it were feasible to enforce such a rule and to collect such information accurately. If not, there is a possibility that a physician with low Medicare volume will have high volume from other patients. If, as a matter of empirical fact, the ratio of Medicare to non-Medicare volume does not vary greatly across doctors in a given specialty or location, a strategy which bases Medicare payment on Medicare volume, "blown up" to include an estimate of typical non-Medicare volume, would probably be workable. Even in this case, one would probably want to use a measure of the total volume recommended by the doctor for his Medicare patients, to avoid the strategy of referring out some Medicare patients in order to get the unit price up. These difficulties do not seem insurmountable. The price would modestly exceed cost for these doctors who do have above-average non-Medicare patients and would fall somewhat short of cost by a small amount for these doctors with a larger Medicare share. However, the latter groups are presumably least likely to reject Medicare patients even if the price is lower.

Neutrality is also lost if different models of test equipment vary in their ratios of fixed to marginal cost. The best strategy here would be to "envelope" the cost function, choosing as the measure of average cost at any volume the level of average cost associated with the cost-minimizing model at that volume. For instance, suppose there are two types of equipment available but one type has lower fixed costs and higher marginal cost than the other. The payment function should then be the line which is the lower boundary of all individual-machine cost functions.

The most important practical question is how to base prices on volumes that have not yet occurred. One feasible strategy would be to base the price for this quarter on the doctors (or practices) volume over the past quarter (or year), and then adjust the price next period based on this quarter's volume experience. One might note that this sort of system is highly compatible with revenue limitation devices.

This strategy is one which can yield prices that approximate lowest average and total cost for any volume, but which does not require HCFA to order the use of particular technology. The main design question is that of the feasibility of monitoring volume.

## CONCLUSIONS ABOUT DIAGNOSTIC TEST PRICING

Medicare is not overpaying for all diagnostic tests, but the payment levels for some tests, when judged by a rate of return approach, might well be out of line. To confirm this suspicion, some more solidly-based empirical measures need to be added to the method we have developed. In addition, and perhaps most importantly, HCFA needs to make a policy decision on what test volume levels it wishes to see provided in doctors' offices.

Judged by the market standard of what other large buyers of tests (IPAs) are paying, Medicare's current price levels appear roughly in line for most of the tests. Compared to prices paid by large IPA-type private health plans, the implicit marginal prices for the technical component and the global fee for diagnostic tests, are generally quite close. 1986 BMAD data, adjusted for inflation by the MEI, was used in a comparison with 1988 price levels for the IPAs.

If Medicare is not paying more than others, is it nevertheless paying more than it should or could? After all, Medicare's large market share potentially gives it the power to push price closer to cost than even aggressive IPAs can do.

While there is some variation in degree, all of these tests make major use of a costly price of capital equipment, and require little or no physician input for performance of the test. It may therefore be possible to determine the appropriate price by calculating the price which yields a normal rate of return on capital investment. A major portion of the project was to develop a method for doing so, and to demonstrate that method using data collected by an informal telephone survey of manufacturers representatives.

A model based on the net present value methodology (NPV) was developed. This method considers the cost of the piece of capital equipment, its maintenance cost, service life, operating cost, and projected volume to arrive at conclusions about pricing. One may either solve for the rate of return implied by a particular price, or solve for that price which yields a rate of return just sufficient to cover the opportunity cost of the doctor's risk capital.

Our analysis showed, in the general case, that determination of price or return requires specification of the volume/utilization rate which is to be produced. There is simply no way of specifying a single appropriate price without first specifying what is regarded as a minimum appropriate volume. Moreover, since higher volume producers will always earn positive (above-normal) profits when the producer with the minimum volume breaks even, there is generally no way to set price equal to cost for all producers.

With these cautions in mind, we estimated normal-return prices in 1988 for alternative plausible volume levels for specialist and generalist physicians; we also estimated normal-return volume given 1986 average prices and costs. For some tests, the current Medicare implicit technical component charge (the difference between global and professional services charges) is close to the price that would represent a breakeven price. But for some other tests, the current Medicare implicit price is several times greater than what we calculate as a breakeven price at plausible volumes. This means either that Medicare is overpaying or that it is supporting volume levels much lower than the minimum plausible volume levels used in our calculations.

The primary value of these net present value calculations is not to set or alter current Medicare prices. Rather, they are intended to illustrate a method for developing such prices, to perform a sensitivity analysis to show what the primary influence on the price is, and, most importantly, to indicate which of these tests would be most useful for further investigation.

Our analysis indicates that current prices for x-rays of all types (chest, orthopedic, GI), EKGs, and CT scans are not obviously inappropriate for at least some specialties. In contrast, under all of the scenarios we examined, the 1986 prices for ophthalmic biometry, echography (ultrasound) and

peripheral vascular testing appear to have been well out of line. For these tests, either the current prices are very wrong or our assumptions need to be shown to be implausible. Whichever is true, further analysis would be warranted. Finally, there is a strong suggestion, but not unequivocal evidence, of overpricing for spirometry (for specialists), and for Holter and real-time EKG monitoring.

There are three kinds of additional analysis that would shed light on these questions. First, it would be useful to document the distribution of total (not just Medicare) test volumes for physician-owned equipment. The most uncertain part of our NPV analysis was the estimation of plausible volumes. Manufacturers' representatives did not feel that they had good information on the volumes doctors envisioned. Instead, sales materials invariably invite doctors to fill in their own estimated volume. The claims for enormous profits or rapid payback of investment for diagnostic testing which are often made all depend critically on volume levels achieved, and are based on volumes that might be judged to be high. It is up to doctors to decide what volume level is plausible for their practices. An empirical study of typical volume levels for physicians who own their own test equipment would therefore be highly valuable. Other BMAD data sets (not the one made available to this project) might permit calculation of the number of Medicare tests associated with a particular physician or physician billing number. Particularly after April, 1988, when a direct billing requirement was instituted so that the doctor could not bill for a global fee for a test that was actually referred out, one might get an accurate idea of the distribution of Medicare volume. But measurement of total volume, Medicare and non-Medicare, is needed to calculate total return, so that a physician survey

(perhaps a modification of the Survey of Physicians' Practice Costs and Income) is suggested.

The second useful piece of information would bear on the value of in-office testing. How much greater convenience, greater access, and greater (or lesser) quality or accuracy is provided to beneficiaries by having in-office testing? Almost any physician in internal medicine would be advised, on quality/liability dimensions alone, to have the capability of administering routine EKGs, but are there other analogous precepts for other specialties and other tests? Some standard-setting, and some analysis of effectiveness and cost, may be appropriate here.

The third piece of information concerns the relationship between test profits and other charges the doctor makes. One might well expect that doctors who profit more from tests they furnish would, on that account, be willing to set prices for other components of the patient encounter lower. As our analysis of Holter monitoring showed, low profits on one task might be offset by high profits on another complementary task. Particularly when some fraction of test users do pay out-of-pocket for doctor visits, doctors may decide to charge less for visits in order to encourage visits when the visit is the gateway to a profitable test. The customary charge rule may link what Medicare pays to a lower office visit price. Before becoming too aggressive about dealing with overpriced tests, one may wisely investigate whether there are offsets elsewhere in the "visit bundle." Nevertheless, the strong profit incentive to test should probably be attenuated even if such offsets are found.

There may be net advantages to Medicare in reducing prices for some tests. However, we argue that a preferable strategy -- and one that does not

require setting volume levels per practice -- is a method of payment in which the unit price depends on volume. Given the heavy fixed cost component for these tests, this may be a reasonable strategy.

The final conclusion appears to be one calling for change, but cautions change. Simply forcing down Medicare payment levels is too much of a blunt instrument. But non-trivial total savings in Medicare costs, and improved incentives, could probably follow from a restructuring of at least some diagnostic test prices.

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